DMEA-2512

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Insert	Letter of Proposal on core analysis
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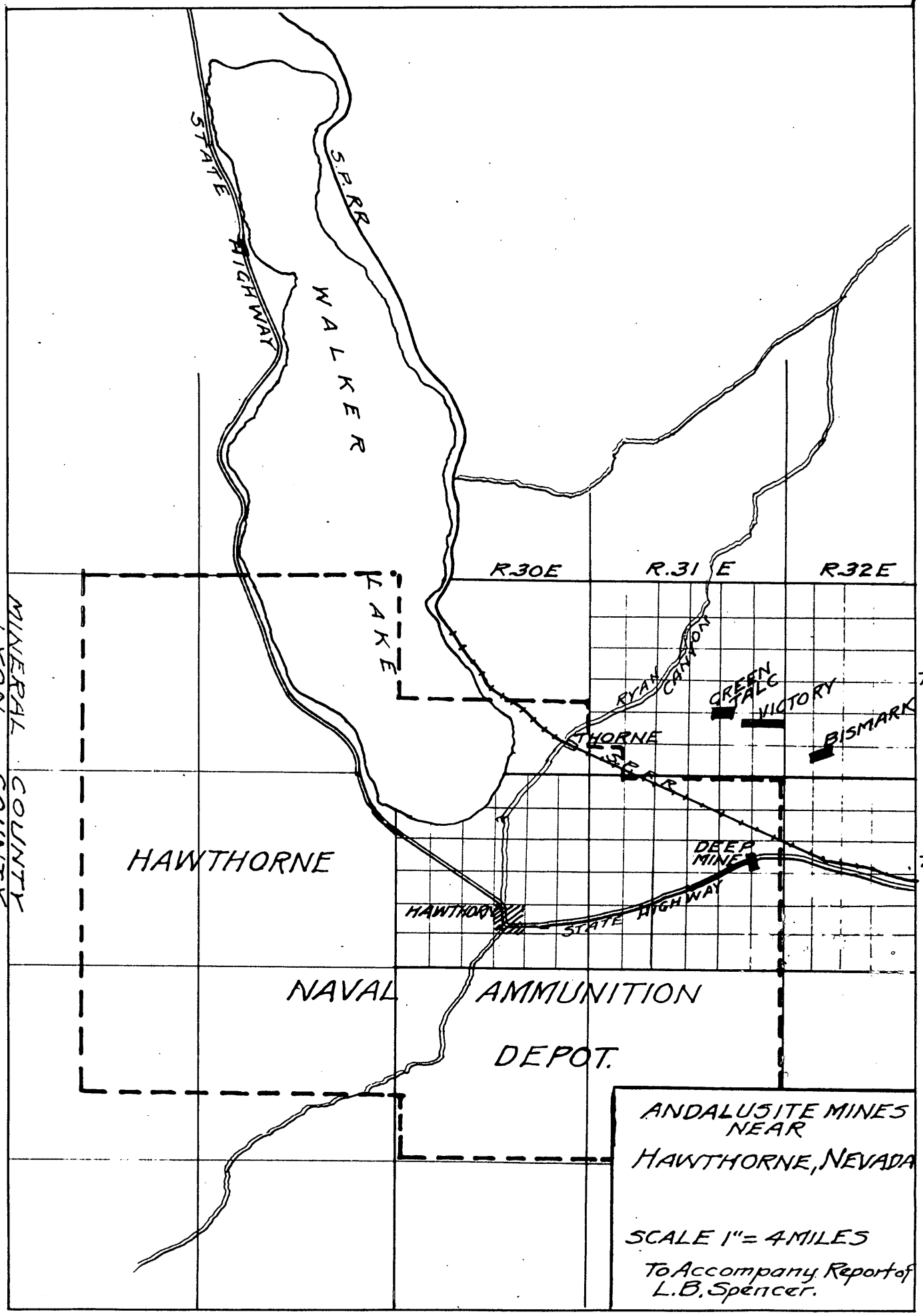
STATE HIGHWAY
S.P.RR
WALKER
LAKE
R.30E
R.31 E
R.32E
T.9N
T.8N
RYAN CANYON
GREEN JACK
VICTORY
BISMARK
THORNE
S.P.R.R.
DEEP MINE
HAWTHORNE
STATE HIGHWAY
MINERAL COUNTY
LYON COUNTY
NAVAL AMMUNITION DEPOT.
ANDALUSITE MINES NEAR HAWTHORNE, NEVADA
SCALE 1" = 4 MILES
To Accompany Report of L.B. Spencer.

rm MF-103
ised June 1951)

UNITED STATES DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION

Budget Bureau No. 42-R1035.1.

MF-103 Should Be Filed With General Technical Data Form MF-100

APPLICATION FOR AID FOR AN EXPLORATION PROJECT PURSUANT TO MINERAL ORDER 5, UNDER DEFENSE PRODUCTION ACT OF 1950

Not To Be Filled in by Applicant

Docket No. DMEA-2512
Metal or Mineral
Date Received 5-5-52
Amount $
Participation (Government %)

CORANDA CORPORATION
386 - RACE STREET
SAN JOSE, CALIFORNIA

Name and address of applicant

Date April 29, 1952

ou have already filed MF-100, give date filed ....., type of assistance requested .....,

DMA Docket Number (if available) .....

INSTRUCTIONS

ead Mineral Order 5, Regulations Governing Government in Defense Projects, before completing this application. mit four copies each, of the signed application form, Gen- l Technical Data Form MF-100, and answers to questions specified, to Defense Minerals Administration, Department the Interior, Washington 25, D. C., or to the nearest field cutive office thereof, with your name and address on each et of the application and all accompanying papers. If you have previously filed MF-100, it is not necessary to file it again. However, you should indicate in space provided above the type of assistance previously applied for (loans, procurement contracts, etc.) and DMA Docket Number, if available. *When a question is inapplicable it should be so stated in the form.* Additional sheets should be attached in answering any questions or in supplying additional information. IF YOU CANNOT ANSWER A QUESTION, SO STATE.

(*a*) Give a description of the real property that will be in any way involved in the exploration project, including any existing mine or operating property.

(*b*) If you are not the owner of the property, submit a copy of the lease, purchase option, or other agreements under which you are authorized to operate the property with each copy of your application.

(*c*) Give the legal description of the exact parcel, plot, or area upon which the exploration is to be conducted.

NOTE: (1) If both areas are the same, so state. The only obligation to repay the Government is from the net earnings from any commercial discovery made in the area specified in (*c*) above in which the exploration is to be conducted, and the expenditure of funds which may be charged as costs of the project must be limited to that area or to work necessary to perform the exploration in that area.

(2) If applicant is not the owner of the property or if there are any liens or encumbrances against the property, copy of agreements of claimants, lienors, encumbrances, and lessors subordinating their interests in the property to the interest of the Government under the Exploration Project Contract will be required for attachment to the Contract.

(*a*) What metals or minerals do you expect to find?

(*b*) Furnish statement of the geologic features of your property, giving type of ore deposit and reasons for expecting to find commercial ore bodies. Illustrate with maps or sketches. If you have a geologic or engineering report, or assay maps showing width and grade, please send them with application, stating whether or not you wish to have them returned.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
MAY 5 1952

The information requested in questions 3, 4, 5, 6, 7, 8, and 9 below should be answered specifically and in detail, as t information will be attached to and incorporated as part of the Exploration Project Contract, if such contract is entered i with you by the Government.

ANSWER EACH QUESTION ON SEPARATE SHEETS OF PAPER AND SUBMIT A COPY OF EACH ANSW FOR EACH COPY OF YOUR APPLICATION.

3. (*a*) Describe fully the proposed work and give the total cost of the project.

   (*b*) State the time required to start the project and to complete it.

4. Submit a map or sketch of the property involved showing a plan (and cross section, if needed) of the present mine worki and the *location of the proposed exploration work* as related to geologic features, such as contacts, veins, ore-bearing beds,

5. Furnish an itemized list of existing facilities, buildings, installations, and fixtures with a statement of the cost of any ne sary rehabilitation or repairs to put into useful and operable condition.

6. Furnish a detailed list of additional facilities, buildings, and fixtures to be purchased, installed, or erected by you, with the e mated cost of each item.

7. Furnish a detailed list of operating equipment, separated into items to be—

   (*a*) Rented

   (*b*) Purchased

   (*c*) Furnished by you

   with the rental, purchase price, or depreciation of each item, as the case may be, to be charged as a cost of the project.

8. Furnish an itemized schedule of labor, by numbers and classes (miners, muckers, etc.) and of supervisors by numbers positions, with the maximum wages or salaries to be paid to each.

9. Furnish a detailed list with estimated cost of each item for materials, supplies, engineering, assaying, accounting, pov water, utilities, and any other items not provided for above.

10. (*a*) How much are you prepared to invest in the proposed project?

    (*b*) Is this amount sufficient to pay your part of the cost of the project, in accordance with the regulations on Governm participation (Sec. 9 of MO–5)?

11. State any conditions or circumstances regarding the property not sufficiently brought out by the foregoing questions.

CERTIFICATION

The undersigned company, and the official executing this certification on its behalf, hereby certify that the information c tained in this form and accompanying papers is correct and complete to the best of their knowledge and belief.

CORANDA CORPORATION
(Name of company)

By J. H. Rodda
(Signature of authorized official)

April 29, 1952
(Date)

President
(Title)

Title 18, U. S. Code (Crimes), Section 1001, makes it a criminal offense to make a willfully false statement or representation to any department or ag of the United States as to any matter within its jurisdiction.

U. S. GOVERNMENT PRINTING OFFICE 16—64067-2

ANSWER SHEET FOR FORM MF -103
APPLICATION FOR AID FOR AN EXPLORATION PROJECT PURSUANT TO MINERAL ORDER 5, UNDER DEFENSE PRODUCTION ACT OF 1950.

For the -

HAWTHORNE ANDALUSITE - CORUNDUM DEPOSITS
THE HAWTHORNE MINING DISTRICT
MINERAL COUNTY, NEVADA

Question 1 (a) and 1 (c)

The Hawthorne Andalusite and Corundum deposits are held by the Coranda Corporation and consist of the following unpatented lode claim groups: The Green Talc Group; the Victory Group; the Bismark Group; and the Deep Mines Group. All of these are located from within eight to twelve miles by road from the town of Hawthorne, Nevada. This area is located East of the southern end of Walker Lake and lies in general within the three townships of Range 31 and 32 East, Township 8 and 9 North, M.D.M., in Mineral County, Nevada. Three of the claim groups, the Green Talc, Victory and Bismark, lie on the southern slope of the Gillis Range of hills. The fourth group, consisting of the Deep Mine Claims, lies between Hawthorne and within a mile of the Southern Pacific Railway, which traverses the central part of Soda Springs Valley.

Location and Legal Description

ALTO AND GREEN TALC CLAIM GROUP:

Hawthorne Mining District, Mineral County, Nevada, approximately 5 miles in a northeasterly direction from Thorne, Nevada, in Township 9 North Range 31 East, in Sections 22, 23, 26 and 27. The claim group consists of Green Talc and Green Talc 1 through 4, the Green Talc Extension and the Alto Claim.

The Alto Claim is located as follows: Corner No. 1 is located 750 feet S47°00-W from the NE Corner of Section 27; thence 1500 feet N77°52-E to Corner No. 2; thence 600 feet S12°08-E to Corner No. 3; thence 1500 feet S77°52-W to Corner No. 4; thence 600 feet N12°08-W to Corner No. 1, the starting point.

The Green Talc Claim No. 1 is located as follows: Corner No. 1 coincides with Corner No. 1 of the Alto Claim; thence 895 feet S77°52-W to Corner No. 2; thence 607 feet N3°14-W to Corner No. 3; thence 897 feet N77°52-E to Corner No. 4; thence 607 feet S3°14-E to Corner No. 1, the starting point.

Question 1 (a) and 1 (c) Cont'd

The Green Talc Claim No. 2 is located as follows: Corner No. 1 coincides with Corner No. 1 of the Alto Claim; thence 607 feet N3°14-W to Corner No. 2; thence 1500 feet N77°52-E to Corner No. 3; thence 607 feet S3°14-E to Corner No. 4; thence 1500 feet S77°52-W to Corner No. 1, the starting point.

The Green Talc Claim No. 3 is located as follows: Corner No. 1 is 262.6 feet N32°57-E from the SW Corner of Section 23; thence 1500 feet S77°52-W to Corner No. 2; thence 396 feet N3°14-W to Corner No. 3; thence 857 feet N63°50-E to Corner No. 4; thence 701 feet N77°52-E to Corner No. 5; thence 607 feet S3°14-E to Corner No. 1, the starting point.

The Green Talc Claim No. 4 is located as follows: Corner No. 1 coincides with Corner No. 1 of the Green Talc Claim No. 3; thence 607 feet N3°14-W to Corner No. 2; thence 1500 feet N77°52-E to Corner No. 3; thence 607 feet S3°14-E to Corner No. 4; thence 1500 feet S77°52-W to Corner No. 1, the starting point.

The Green Talc Extension is located as follows: Corner No. 1 coincides with Corner No. 1 of the Alto Claim; thence 600 feet S12°08-E to Corner No. 2; thence 1500 feet S77°52-W to Corner No. 3; thence 600 feet N12°08-W to Corner No. 4; thence 1500 feet N77°52-E to Corner No. 1, the starting point.

The Green Talc Claim is located as follows: Corner No. 1 coincides with Corner No. 2 of the Green Talc Claim No. 1; thence 831 feet S77°52-W to Corner No. 2; thence 607 feet N3°14-W to Corner No. 3; thence 832 feet N77°52-E to Corner No. 4; thence 607 feet S3°14-E to Corner No. 1, the starting point.

BISMARK GROUP:

Hawthorne Mining District, Mineral County, Nevada; approximately 8 miles due East of the town of Thorne, Nevada, in Township 9 North Range 32 East, in Sections 31 and 32.

The Bismark Claim is located as follows: Corner No. 1 is located approximately 870 feet due South and 425 feet due East of the NE Corner of Section 32; thence 705 feet S57°15-W to Corner No. 2; thence 600 feet N7°00-E to Corner No. 3; thence 705 feet N57°15-E to Corner No. 4; thence 600 feet S7°00-W to Corner No. 1, the starting point.

Question 1 (a) and 1 (c) Cont'd

The Bismark Claim No. 1 is located as follows: Corner No. 1 is located 870 feet due South and 425 feet due East of the NW Corner of Section 32; thence 600 feet N7°00-E to Corner No. 2; thence 452 feet N57°15-E to Corner No. 3; thence 987 feet S83°00-E to Corner No. 4; thence 600 feet S7°00-W to Corner No. 5; thence 987 feet N83°00-W to Corner No. 6; thence 452 feet S57°15-W to Corner No. 1, the starting point.

The Bismark Claim No. 4 is located as follows: Corner No. 1 is located 870 feet due South and 425 feet due East of the NW Corner of Section 32; thence 795 feet N57°15-E to Corner No. 2; thence 600 feet S7°00-W to Corner No. 3; thence 1500 feet S57°15-W to Corner No. 4; thence 600 feet N7°00-E to Corner No. 5; thence 705 feet N57°15-E to Corner No. 1, the starting point.

DEEP MINES GROUP:

Hawthorne Mining District, Mineral County, Nevada; approximately 7 miles southeasterly of Thorne, Nevada, and approximately 8 miles in a northeasterly direction of Hawthorne; located in Township 8 North Range 31 East, M.D.M., in Sections 13, 14, 23 and 24.

The Deep Mine Claim is located as follows: Corner No. 1 is located approximately 650 feet N35°00-W from the SE Corner of Section 14; thence to Corner No. 2, 1500 feet N51°00-W; thence 600 feet N39°00-E to Corner No. 3; thence 1500 feet S51°00-E to Corner No. 4; thence 600 feet S39°00-W to Corner No. 1, the starting point.

Deep Mine No. 1 Claim is located as follows: Corner No. 1 is located approximately 650 feet N35°00-W from the SE Corner of Section 14; thence 600 feet N39°00-E to Corner No. 2; thence 1500 feet S51°00-E to Corner No. 3; thence 600 feet S39°00-W to Corner No. 4; thence 1500 feet N51°00-W to Corner No. 1, the starting point.

VICTORY GROUP:

Victory Claim No. 1 is located as follows: Corner No. 1 is located 2,050 feet due South of the Northwest Corner of Section 25, Township 9 North Range 31 East in the Hawthorne Mining District, Mineral County, Nevada. From Corner No. 1, thence 600 feet N25°00-E to Corner No. 2; thence 748 feet S69°56-E to Corner No. 3; thence 752 feet S41°00-E to Corner No. 4; thence 600 feet S25°00-W to Corner No. 5; thence 752 feet N41°00-W to Corner No. 6; thence 748 feet N69°56-W to Corner No. 1, the starting point.

Question 1 (a) and 1 (c) Cont'd

Victory Claim No. 2 is located as follows: Corner No. 1 coincides with Corner No. 1 of Victory Claim No. 1; thence 1500 feet N70°56-W to Corner No. 2; thence 600 feet N25°00-E to Corner No. 3; thence 1500 feet S70°56-E to Corner No. 4; thence 600 feet S25°00-W to Corner No. 1, the starting point.

Victory Claim No. 3 is located as follows: Corner No. 1 coincides with Corner No. 2 of Victory Claim No. 2; thence 392 feet S83°10-W to Corner No. 2; thence 1104 feet N89°47-W to Corner No. 3; thence 600 feet N25°00-E to Corner No. 4; thence 1104 feet S89°47-E to Corner No. 5; thence 392 feet N83°10-E to Corner No. 6; thence 600 feet S25°00-W to Corner No. 1, the starting point.

Victory Claim No. 6 is located as follows: Corner No. 1 coincides with Corner No. 3 of Victory No. 3; thence 450 feet N78°57-W to Corner No. 2; thence approximately 730 feet N67°00-W to Corner No. 3; thence 600 feet N25°00-E to Corner No. 4; thence approximately 730 feet S67°00-E to Corner No. 5; thence 450 feet S78°57-E to Corner No. 6; thence 600 feet S25°00-W to Corner No. 1, the starting point.

Victory Claim No. 4 is located as follows: Corner No. 1 is 400 feet N41°00-W of Corner No. 3 of Victory Claim No. 1; thence 1488 feet N81°00-E to Corner No. 2; thence 600 feet S41°00-E to Corner No. 3; thence 1488 feet S81°00-W to Corner No. 4; thence 200 feet N41°00-W to Corner No. 3 of Victory Claim no. 1, the starting point.

Victory Claim No. 5 is located as follows: Corner No. 1 coincides with Corner No. 2 of Victory Claim No. 4; thence 700 feet N74°27-E to Corner No. 2; thence 700 feet N77°15-E to Corner No. 3; thence 600 feet S41°00-E to Corner No. 4; thence 700 feet S77°15-W to Corner No. 5; thence 700 feet S74°27-W to Corner No. 6; thence 600 feet N41°00-W to Corner No. 1, the starting point.

OPTION TO PURCHASE

THIS OPTION TO PURCHASE made and executed this 1st day of January, 1952, by and between ESTHER REA and JOHN VUICH, of Hawthorne, Nevada, parties of the first part, hereinafter called "Owners", and FRED FULKERSON, 77 North 27th Street, San Jose, California, ROBERT B. HOLT, Box 578, Centerville, California, and J. H. RODDA, 1291 Emory St., San Jose 26, California, parties of the second part, hereinafter called "Purchasers",

W I T N E S S E T H:

1. That the Owners, in consideration of the sum of One ($1.00) Dollar, to them in hand paid by the Purchasers, receipt whereof is hereby acknowledged, do hereby agree to sell and/or convey to Purchasers all that certain mining property situate in the Gillis Range Mining District, County of Mineral, State of Nevada, the notices of location of which are recorded in the Book of Mining Locations in the Office of the County Recorder of Mineral County, Hawthorne, Nevada, as follows:

NAME OF CLAIM	FILE NO.	BOOK NO.	PAGE	DATE DISCOVERED	DATE FILED
Green Talc	20,770	8	535	10-5-29	1-3-30
Green Talc No. 1	20,771	8	535	10-5-29	1-3-30
Green Talc No. 2	20,772	8	535) 536)	10-5-29	1-3-30
Green Talc No. 3	21,342	9	17	6-7-30	8-22-30
Green Talc No. 4	21,343	9	17	6-7-30	8-22-30
Alto Mining Claim	32,490	11	578) 579)	6-8-41	6-8-41
Green Talc Extension	32,498	11	587	6-8-41	6-8-41
Maps on above		12	583		

2. The Purchasers are hereby given six (6) months' Option to Purchase said property, from Monday, January 1, 1952, to Tuesday, July 1, 1952.

3. The total purchase price shall be Two Hundred Thousand ($200,000) Dollars cash payable on or before July 1, 1952.

4. If cash is not paid on or before July 1, 1952, then the following terms on the purchase price of Two Hundred Thousand ($200,000) Dollars are set forth:

(a) Ten Percent (10%), or Twenty Thousand ($20,000) Dollars down payment on or before July 1, 1952.

(b) Ten Percent (10%), or Twenty Thousand ($20,000) Dollars payment one year from date of the first payment, and Twenty Thousand ($20,000) Dollars payment each and every year on the said date of the first payment, for ten (10) consecutive years, or until the purchase price is paid.

(c) One ($1.00) Dollar a ton royalty on all ore or concentrates shipped from the property, to apply on purchase price.

5. As an alternative, the following terms are set forth in lieu of cash:

(a) Two Hundred ($200.00) Dollars minimum royalty down payment on or before July 1, 1952.

(b) Two Hundred ($200.00) Dollars on the 15th day of the month following the first minimum royalty payment, and Two Hundred ($200.00) Dollars on the 15th day of each consecutive month thereafter.

(c) One ($1.00) Dollar a ton royalty on all ore or concentrates shipped from the property, to apply on purchase price.

(d) The total purchase price of Two Hundred Thousand ($200,000) Dollars shall be payable on or before July 1, 1962.

6. If cash is paid for the property, abstract of title will be furnished by Owners to Purchasers upon the receipt of the cash payment.

7. If property is taken on minimum royalty basis, the down payment of Two Hundred ($200.00) Dollars minimum royalty will be placed in escrow with the escrow holder with instructions to pay it to Owners as soon as an abstract of title to said mining property has been completed by an authorized abstractor showing the title to said property to be free and clear of all liens and encumbrances, said abstract to be deposited with the escrow holder.

8. It is understood and agreed that upon the execution of this Option to Purchase, Purchasers may go into possession of said property for the purpose of preliminary development work.

9. The One ($1.00) Dollar a ton royalty for all products shipped from said mining property during any month, shall be paid on the 15th day of each calendar month for all products removed the preceding month. The monthly minimum royalty, after the first down payment, plus any additional tonnage royalty, shall become due and payable on the 15th day of each month.

10. Said royalties shall be sent to the Nevada Bank of Commerce, 1 North Virginia Street, Reno, Nevada. A letter of instruction to said Bank is attached to this Option to Purchase.

11. Tonnage of products removed shall be determined by waybill, if shipped by railroad, or if shipped by other conveyance it shall be weighed by a licensed weight master and copies of such waybills or weight receipts, together with a statement from the office of the company of such tonnage products, shall be mailed with royalty payments monthly to the escrow holder to be delivered to Owners on the 15th day of each month.

12. If this property is purchased for cash, the Owners will furnish a good and sufficient quit-claim deed showing the said mining property clear of encumbrances.

13. Annual assessment work on said mining claims shall be done by the Purchasers for the year ending June 30, 1952, and each succeeding year that this Option to Purchase is in operation, and recorded by Purchasers before July 1st of each year, with the County Recorder in Mineral County, Nevada, a receipt of the filing of said assessment work to be furnished the Owners through the escrow holder.

14. Purchasers shall pay all Federal, state, county, school and all other taxes, levies, assessments and charges that may be levied against said premises, the ores and products removed

therefrom, and on all improvements placed by them on said property.

15. Purchasers agree to comply with all laws, both Federal and state, and the usual requirements of the State of Nevada regarding safeguards around mines, the Industrial Liability Insurance, the Workmen's Compensation Law of the State of Nevada, and the carrying on of all operations in a safe, sane and minerlike manner shall be met in all particulars.

16. Before commencing any work on said mining property, Purchasers agree to file and keep on file and of record in the Office of the County Recorder of Mineral County, Nevada, and to post and keep posted on said mining property, notices to the effect that said mining claims are being operated by them as Purchasers, as independent contractors, and no bills for labor or material furnished shall hold the property responsible in any way.

17. Inspection and free access to all parts of the property shall be available to any of the owners at any and all times.

18. Full and complete records of all shipments made from the property shall be kept at the main office of the Purchasers, which records shall at all times be open for inspection and check by the Owners.

19. Purchasers agree to work and operate said mining property in a minerlike fashion, it being understood that minerlike fashion shall consist of open-pit mining, tunnelling, shaft work, or any other economical form of mining. It is understood that the ore and the waste shall be placed on separate dumps, if, for any reason, it has to be stockpiled.

20. If any tonnage of ore is shipped from this property from the date of this instrument to July 1, 1952, or to the time of the first payment from Purchasers to Owners, a royalty of One ($1.00) Dollar a ton shall be paid, said royalty payments to be made to the Owners on the 15th day of the calendar month following the month of removal thereof. Said payments shall be accompanied

by way bill or weight receipt, together with a statement from the office of the company of purchasers of such tonnage products, as provided for the payment of other royalties hereunder.

21. Upon failure of Purchasers to comply with the conditions hereof, forfeiture of this Option to Purchase may be made on thirty (30) days' notice, in writing, by Owners to Purchasers, by registered mail, and all moneys theretofore paid to Owners shall be deemed forfeited and liquidated and Purchasers shall have thirty (30) days from the date of such notice to remove their equipment from said property.

22. The terms of the aforesaid Option to Purchase shall extend to and be binding upon all parties, and executors and administrators of all parties to the Option to Purchase.

23. The Purchasers shall have the right to patent the said mining claims at any time during the existence of this Option to Purchase. If it is before they may acquire title to the property, it is agreed that the property may be patented in the names of the Owners.

24. Time and compliance with the conditions above set forth are the essence of this Option to Purchase, and should the Purchasers fail to comply with, or violate any of the provisions herein, then at the option of the Owners, on written notice, as specified in Paragraph 21, above, this Option to Purchase shall terminate and be void and the Owners shall enter in and upon said mining claims and, using any and all necessary force, shall take possession and remove Purchasers, their employees and agents therefrom and, upon said doing, the Owners are hereby released from any and all liability in the premises.

25. The Owners of said claims agree to sign a subordination agreement as required by the Reconstruction Finance Corporation or other lending institution.

25. The tailings remaining on the mill site shall become the property of the owners in the event and at the time of default.

26. In the event of War, Strikes or an Act of God, the time and conditions of this contract and agreement shall be extended by the length of such delay.

IN WITNESS WHEREOF, the parties hereto have hereunto set their hands the day and year first above written.

ESTHER REA
ESTHER REA

JOHN VUICH
JOHN VUICH

OWNERS

FRED FULKERSON
FRED FULKERSON

ROBERT B. HOLT
ROBERT B. HOLT

J. H. RODDA
J. H. RODDA

PURCHASERS

WITNESS: WILLIAM REA

WITNESS: NEVA FERRETTI

OPTION TO PURCHASE

THIS OPTION TO PURCHASE made and executed this 1st day of January, 1952, by and between ESTHER REA, JOE MALATESTA, EUGENE FERRETTI and JOHN VUICH, of Hawthorne, Nevada, parties of the first part, hereinafter called "Owners", and FRED FULKERSON, 77 North 27th Street, San Jose, California, ROBERT B. HOLT, Box 578, Centerville, California, and J. H. RODDA, 1291 Emory St., San Jose 26, California, parties of the second part, hereinafter called "Purchasers,

W I T N E S S E T H :

1. That the Owners, in consideration of the sum of One ($1.00) Dollar, to them in hand paid by the Purchasers, receipt whereof is hereby acknowledged, do hereby agree to sell and/or convey to purchasers all that certain mining property situate in the Gillis Range Mining District, County of Mineral, State of Nevada, the notices of location of which are recorded in the Book of Mining Locations in the Office of the County Recorder of Mineral County, Hawthorne, Nevada as follows:

NAME OF CLAIM	FILE NO.	BOOK NO.	PAGE	DATE DISCOVERED	DATE FILED
Bismark No. 1	25323	10	110	7-11-35	9-14-35
Bismark Mine	25324	10	110	7-11-35	9-14-35

2. The Purchasers are hereby given six (6) months' Option to Purchase said property, from Monday, January 1, 1952, to Tuesday, July 1, 1952.

3. The total purchase price shall be Forty Thousand ($40,000) Dollars cash, payable on or before July 1, 1952.

4. If cash is not paid on or before July 1, 1952, then the following terms on the purchase price of Forty Thousand ($40,000) Dollars are set forth:

(a) Twenty per cent (20%, or Eight Thousand ($8,000) Dollars down payment on or before July 1, 1952.

(b) Twenty per cent (20%) or Eight Thousand ($8,000) Dollars payment one year from date of the first payment,

and Eight Thousand ($8,000) Dollars payment each and every year on the said date of the first payment, for five (5) consecutive years, or until the purchase price is paid.

(c) One ($1.00) Dollar a ton royalty on all ore or concentrates shipped from the property, to apply on purchase price.

5. As an alternative, the following terms are set forth in lieu of cash:

(a) One Hundred Fifty ($150.00) Dollars minimum royalty down payment on or before July 1, 1952.

(b) One Hundred Fifty ($150.00) Dollars on the 15th day of the month following the first minimum royalty payment, and One Hundred Fifty ($150.00) Dollars on the 15th day of each consecutive month thereafter.

(c) One ($1.00) Dollar a ton royalty on all ore or concentrates shipped from the property, to apply on purchase price.

(d) The total purchase price of Forty Thousand ($40,000) Dollars shall be payable on or before July 1, 1957.

6. If cash is paid for the property, abstract of title will be furnished by Owners to Purchasers upon the receipt of the cash payment.

7. If property is taken on minimum royalty basis, the down payment of One Hundred Fifty ($150.00) Dollars minimum royalty will be placed in escrow with the escrow holder with instructions to pay it to Owners as soon as an abstract of title to said mining property has been completed by an authorized abstractor showing the title to said property to be free and clear of all liens and encumbrances, said abstract to be deposited with the escrow holder.

8. It is understood and agreed that upon the execution of this Option to Purchase, Purchasers may go into possession of said property for the purpose of preliminary development work.

9. The One ($1.00) Dollar a ton royalty for all products shipped from said mining property during any month, shall be paid on

the 15th day of each calendar month for all products removed the preceding month. The monthly minimum royalty, after the first down payment, plus any additional tonnage royalty, shall become due and payable on the 15th day of each month.

10. Said royalties shall be sent to the Nevada Bank of Commerce, 1 North Virginia Street, Reno, Nevada. A letter of instruction to said Bank is attached to this Option to Purchase.

11. Tonnage or products removed shall be determined by waybill, if shipped by railroad, or if shipped by other conveyance it shall be weighed by a licensed weight master and copies of such waybills or weight receipts, together with a statement from the office of the company of such tonnage products, shall be mailed with royalty payments monthly to the escrow holder to be delivered to Owners on the 15th day of each month.

12. If this property is purchased for cash, the Owners will furnish a good and sufficient quit-claim deed showing the said mining property clear of encumbrances.

13. Annual assessment work on said mining claims shall be done by the Purchasers for the year ending June 30, 1952, and each succeeding year that this Option to Purchase is in operation and recorded by Purchasers before July 1st of each year, with the County Recorder in Mineral County, Nevada, a receipt of the filing of said assessment work to be furnished the Owners through the escrow holder.

14. Purchasers shall pay all Federal, state, county, school and all other taxes, levies, assessments and charges that may be levied against said premises, the ores and products removed therefrom, and on all improvements placed by them on said property.

15. Purchasers agree to comply with all laws, both Federal and State, and the usual requirements of the State of Nevada regarding safeguards around mines, the Industrial Liability Insurance, the Workmen's Compensation Law of the State of Nevada, and the carrying on of all operations in a safe, sane and minerlike manner shall be

met in all particulars.

16. Before commencing any work on said mining property, Purchasers agree to file and keep on file and of record in the Office of the County Recorder of Mineral County, Nevada, and to post and keep posted on said mining property, notices to the effect that said mining claims are being operated by them as Purchasers, as independent contractors, and no bills for labor or material furnished shall hold the property responsible in any way.

17. Inspection and free access to all parts of the property shall be available to any of the owners at any and all times.

18. Full and complete records of all shipments made from the property shall be kept at the main office of the Purchasers, which records shall at all times be open for inspection and check by the Owners.

19. Purchasers agree to work and operate said mining property in a minerlike fashion, it being understood that minerlike fashion shall consist of open-pit mining, tunnelling, shaft work, or any other economical form of mining. It is understood that the ore and the waste shall be placed on separate dumps, if, for any reason, it has to be stockpiled.

20. If any tonnage of ore is shipped from this property from the date of this instrument to July 1, 1952, or to the time of the first payment from Purchasers to Owners, a royalty of One($1.00) Dollar a ton shall be paid, said royalty payments to be made to the Owners on the 15th day of the calendar month following the month of removal thereof. Said payments shall be accompanied by way bill or weight receipt, together with a statement from the office of the company of purchasers of such tonnage products, as provided for the payment of other royalties hereunder.

21. Upon failure of Purchasers to comply with the conditions hereof, forfeiture of this Option to Purchase may be made on thirty (30) days' notice, in writing, by Owners to Purchasers, by registered

mail, and all moneys theretofore paid to Owners shall be deemed forfeited and liquidated and Purchasers shall have thirty (30) days from the date of such notice to remove their equipment from said property.

22. The terms of the aforesaid Option to Purchase shall extend to and be binding upon all parties, and executors and administrators of all parties to the Option to Purchase.

23. The Purchasers shall have the right to patent the said mining claims at any time during the existence of this Option to Purchase. If it is before they may acquire title to the property, it is agreed that the property may be patented in the names of the Owners.

24. Time and compliance with the conditions above set forth are the essence of this Option to Purchase, and should the Purchasers fail to comply with, or violate any of the provisions herein, then at the option of the Owners, on written notice, as specified in Paragraph 21, above, this Option to Purchase shall terminate and be void and the Owners shall enter in and upon said mining claims and, using any and all necessary force, shall take possession and remove Purchasers, their employees and agents therefrom and, upon said doing, the Owners are hereby released from any and all liability in the premises.

25. The Owners of said claims agree to sign a subordination agreement as required by the Reconstruction Finance Corporation or other lending institution.

25. The tailings remaining on the mill site shall become the property of the owners in the event and at the time of default.

26. In the event of War, Strikes, or an act of God, the time and conditions of this contract and agreement shall be extended by the length of such delay.

IN WITNESS WHEREOF, the parties hereto have hereunto set

their hands the day and year first above written.

ESTHER REA
ESTHER REA

JOE MALATESTA
JOE MALATESTA

E. FERRETTI
EUGENE FERRETTI

JOHN VUICH
JOHN VUICH

OWNERS

FRED FULKERSON
FRED FULKERSON

ROBERT B. HOLT
ROBERT B. HOLT

J. H. RODDA
J.H. RODDA

PURCHASERS

WITNESS: WILLIAM REA

WITNESS: NEVA FERRETTI

OPTION TO PURCHASE

THIS OPTION TO PURCHASE, made and executed this 1st day of January, 1952, by and between ESTHER REA, JOE MALATESTA, and EUGENE FERRETTI, of Hawthorne, Nevada, parties of the first part, hereinafter called "Owners", and FRED FULKERSON, 77 North 27th Street, San Jose, California, ROBERT B. HOLT, Box 578, Centerville, California, and J. H. RODDA, 1291 Emory St., San Jose 26, California, parties of the second part, heretofore called "Purchasers",

W I T N E S S E T H:

1. That the Owners, in consideration of the sum of One ($1.00) Dollar, to them in hand paid by the Purchasers, receipt whereof is hereby acknowledged, do hereby agree to sell and/or convey to Purchasers all that certain mining property situate in the Gillis Range Mining District, County of Mineral, State of Nevada, the notices of location of which are recorded in the Book of Mining Locations in the Office of the County Recorder of Mineral County, Hawthorne, Nevada, as follows:

NAME OF CLAIM	FILE NO.	BOOK NO.	PAGE	DATE DISCOVERED	DATE FILED
Victory No. 1	35,042	12	232-233	12-19-42	3-18-43
Victory No. 2	35,043	12	233	12-19-42	3-18-43
Victory No. 3	35,044	12	233	12-19-42	3-18-43
Victory No. 5	35,044	12	233	12-28-42	3-18-43
Victory No. 6	35,046	12	234	12-28-42	3-19-43

2, The Purchasers are hereby given six (6) months' Option to Purchase said property, from Monday, January 1, 1952, to Tuesday, July 1, 1952.

3. The total purchase price shall be Thirty Thousand ($30,000.00) Dollars cash payable on or before July 1, 1952.

4. If cash is not paid on or before July 1, 1952, then the following terms on the purchase price of Thirty Thousand ($30,000) Dollars are set forth:

(a) Twenty percent (20%), or Six Thousand ($6,000) Dollars down payment on or before July 1, 1952.

(b) Twenty Percent (20%), or Six Thousand ($6,000) Dollars payment one year from date of the first payment, and Six Thousand ($6,000) Dollars payment each and every year on the said date of the first payment, for five (5) consecutive years, or until the purchase price is paid.

(c) One ($1.00) Dollar a ton royalty on all ore or concentrates shipped from the property, to apply on purchase price.

5. As an alternative, the following terms are set forth in lieu of cash:

(a) One Hundred Fifty ($150.00) Dollars minimum royalty down payment on or before July 1, 1952.

(b) One Hundred Fifty ($150.00) Dollars on the 15th day of the month following the first minimum royalty payment, and One Hundred Fifty ($150.00) Dollars on the 15th day of each consecutive month thereafter.

(c) One ($1.00) Dollar a ton royalty on all ore or concentrates shipped from the property, to apply on purchase price.

(d) The total purchase price of Thirty Thousand ($30,000) Dollars shall be payable on or before July 1, 1957.

6. If cash is paid for the property, abstract of title will be furnished by Owners to Purchasers upon the receipt of the cash payment.

7. If property is taken on minimum royalty basis, the down payment of One Hundred Fifty ($150.00) Dollars minimum royalty will be placed in escrow with the escrow holder with instructions to pay it to Owners as soon as an abstract of title to said mining property has been completed by an authorized abstractor showing the title to said property to be free and clear of all liens and encumbrances, said abstract to be deposited with the escrow holder.

8. It is understood and agreed that upon the execution of this Option to Purchase, Purchasers may go into possession of said property for the purpose of preliminary development work.

9. The One ($1.00) Dollar a ton royalty for all products shipped from said mining property during any month, shall be paid on the 15th day of each calendar month for all products removed the preceding month. The monthly minimum royalty, after the first down payment, plus any additional tonnage royalty, shall become due and payable on the 15th day of each month.

10. Said royalties shall be sent to the Nevada Bank of Commerce, 1 North Virginia Street, Reno, Nevada. A letter of instruction to said Bank is attached to this Option to Purchase.

11. Tonnage of products removed shall be determined by waybill, if shipped by railroad, or if shipped by other conveyance it shall be weighed by a licensed weight master and copies of such waybills or weight receipts, together with a statement from the office of the company of such tonnage products, shall be mailed with royalty payments monthly to the escrow holder to be delivered to Owners on the 15th day of each month.

12. If this property is purchased for cash, the Owners will furnish a good and sufficient quit-claim deed showing the said mining property clear of encumbrances.

13. Annual assessment work on said mining claims shall be done by the Purchasers for the year ending June 30, 1952, and each succeeding year that this Option to Purchase is in operation and recorded by Purchasers before July 1st of each year, with the County Recorder in Mineral County, Nevada, a receipt of the filing of said assessment work to be furnished the Owners through the escrow holder.

14. Purchasers shall pay all Federal, state, county, school and all other taxes, levies, assessments and charges that may be levied against said premises, the ores and products removed

therefrom, and on all improvements placed by them on said property.

15. Purchasers agree to comply with all laws, both Federal and state, and the usual requirements of the State of Nevada regarding safeguards around mines, theIndustrial Liability Insurance, the Workmen's Compensation Law of the State of Nevada, and the carrying on of all operations in a safe, sane and minerlike manner shall be met in all particulars.

16. Before commencing any work on said mining property, Purchasers agree to file and keep on file and of record in the Office of the County Recorder of Mineral County, Nevada, and to post and keep posted on said mining property, notices to the effect that said mining claims are being operated by them as Purchasers, as independent contractors, and no bills for labor or material furnished shall hold the property responsible in any way.

17. Inspection and free access to all parts of the property shall be available to any of the owners at any and all times.

18. Full and complete records of all shipments made from the property shall be kept at the main office of the Purchasers, which records shall at all times be open for inspection and check by the Owners.

19. Purchasers agree to work and operate said mining property in a minerlike fashion, it being understood that minerlike fashion shall consist of open-pit mining, tunnelling, shaft work, or any other economical form of mining. It is understood that the ore and the waste shall be placed on separate dumps, if, for any reason, it has to be stockpiled.

20. If any tonnage of ore is shipped from this property from the date of this instrument to July 1, 1952, or to the time of the first payment from Purchasers to Owners, a royalty of One ($1.00) Dollar a ton shall be paid, said royalty payments to be made to the Owners on the 15th day of the calendar month following the month of removal thereof. Said payments shall be accompanied

by way bill or weight receipt, together with a statement from the office of the company of purchasers of such tonnage products, as provided for the payment of other royalties hereunder.

21. Upon failure of Purchasers to comply with the conditions hereof, forfeiture of this Option to Purchase may be made on thirty (30) days' notice in writing, by Owners to Purchasers, by registered mail, and all moneys theretofore paid to Owners shall be deemed forfeited and liquidated and Purchasers shall have thirty (30) days from the date of such notice to remove their requipment from said property.

22. The terms of the aforesaid Option to Purchase shall extend to and be binding uponnall parties, and executors and administrators of all parties to the Option to Purchase.

23. The Purchasers shall have the right to patent the said mining claims at any time during the existence of this Option to Purchase. If it is before they may acquire title to the property, it is agreed that the property may be patented in the names of the Owners.

24. Time and compliance with the conditions above set forth are the essence of this Option to Purchase, and should the Purchasers fail to comply with, or violate any of the provisions herein, then at the option of the Owners, on written notice, as specified in Paragraph 21, above, this Option to Purchase shall terminate and be void and the Owners shall enter in and upon said mining claims and, using any and all necessary force, shall take possession and remove Purchasers, their employees and agents therefrom and, upon said doing, the Owners are hereby released from any and all liability in the premises.

The Owners of said claims agree to sign a subordination agreement as required by the Reconstruction Finance Corporation or other lending institution.

25. The tailings remaining on the mill site shall become the property of the owners in the event and at the time of default.

26. In the event of War, Strikes or an act of God, the time and conditions of this contract and agreement shall be extended by the length of such delay.

IN WITNESS WHEREOF, the parties hereto have hereunto set their hands the day and year first above written.

ESTHER REA
ESTHER REA

JOE MALATESTA
JOE MALATESTA

E. FERRETTI
EUGENE FERRETTI

OWNERS

FRED FULKERSON
FRED FULKERSON

ROBERT B.HOLT
ROBERT B. HOLT

J. H. RODDA
J. H. RODDA

PURCHASERS

WITNESS: WILLIAM REA

WITNESS: NEVA FERRETTI

OPTION TO PURCHASE

THIS OPTION TO PURCHASE made and executed this 1st day of January, 1952, by and between JOE MALATESTA, EUGENE FERRETTI and JOHN VUICH, of Hawthorne, Nevada, parties of the first part,hereinafter called "Owners", and FRED FULKERSON, 77 North 27th Street, San Jose, California, ROBERT B. HOLT, Box 578, Centerville, California, and J. H. RODDA, 1291 Emory St., San Jose 26, California, parties of the second part, hereinafter called "Purchasers",

W I T N E S S E T H:

1. That the Owners, in consideration of the sum of One ($1.00) Dollar, to them in hand paid by the Purchasers, receipt whereof is hereby acknowledged, do hereby agree to sell and/or convey to Purchasers all that certain mining property situate in the Gillis Range Mining District, County of Mineral, State of Nevada, the notices of location of which are recorded in the Book of Mining Locations in the Office of the County Recorder of Mineral County, Hawthorne, Nevada, as follows:

NAME OF CLAIM	FILE NO.	DATE DISCOVERED	DATE FILED
Deep Mines	17,079	10-28-25	11-16-25
Deep Mines No.1	17,080	10-28-25	11-16-25

2. The Purchasers are hereby given six (6) months' Option to Purchase said property, from Monday, January 1, 1952, to Tuesday, July 1, 1952.

3. The total purchase price shall be Forty Thousand ($40,000) Dollars cash, payable on or before July 1, 1952.

4. If cash is not paid on or before July 1, 1952, then the following terms on the purchase price of Forty Thousand ($40,000) Dollars are set forth:

(a) Twenty Percent (20%), or Eight Thousand ($8,000.00) Dollars down payment on or before July 1, 1952.

(b) Twenty Percent (20%), or Eight Thousand ($8,000) Dollars payment one year from date of the first payment.

and ($8,000) Eight Thousand Dollars payment each and every year on the said date of the first payment, for five (5) consecutive years, or until the purchase price is paid.

(c) One ($1.00) Dollar a ton royalty on all ore or concentrates shipped from the property, to apply on purchase price.

8. As an alternative, the following terms are set forth in lieu of cash:

(a) One Hundred and Fifty ($150.00) Dollars minimum royalty down payment on or before July 1, 1952.

(b) One Hundred and Fifty ($150.00) Dollars on the 15th day of the month following the first minimum royalty payment, and One Hundred Fifty ($150.00) Dollars on the 15th day of each consecutive month thereafter.

(c) One ($1.00) Dollar a ton royalty on all ore or concentrates shipped from the property, to apply on purchase price.

(d) The total purchase price of Forty Thousand ($40,000) Dollars shall be payable on or before July 1, 1957.

6. If cash is paid for the property, abstract of title will be furnished by Owners to Purchasers upon the receipt of the cash payment.

7. If property is taken on a minimum royalty basis, the down payment of One Hundred Fifty ($150.00) Dollars minimum royalty will be placed in escrow with the escrow holder with instructions to pay it to Owners as soon as an abstract of title to said mining property has been completed by an authorized abstractor showing the title to said property to be free and clear of all liens and encumbrances, said abstract to be deposited with the escrow holder.

8. It is understood and agreed that upon the execution of this Option to Purchase, Purchasers may go into possession of said property for the purpose of preliminary development work.

9. The One ($1.00) Dollar a ton royalty for all products shipped from said mining property during any month, shall be paid on the 15th day of each calendar month for all products removed the preceding month. The monthly minimum royalty, after the first down payment, plus any additional tonnage royalty, shall become due and payable on the 15th day of each month.

10. Said royalties shall be sent to the Nevada Bank of Commerce, 1 North Virginia Street, Reno, Nevada, A letter of instruction to said Bank is attached to this Option to Purchase.

11. Tonnage of products removed shall be determined by waybill, if shipped by railroad, or if shipped by other conveyance it shall be weighed by a licensed weight master and copies of such waybills or weight receipts, together with a statement from the office of the company of such tonnage products, shall be mailed with royalty payments monthly to the escrow holder to be delivered to Owners on the 15th day of each month.

12. If this property is purchased for cash, the Owners will furnish a good and sufficient quit-claim deed showing the said mining property clear of encumbrances.

13. Annual assessment work on said mining claims shall be done by the Purchasers for the year ending June 30, 1952, and each succeeding year that this Option to Purchase is in operation, and recorded by Purchasers before July 1st of each year, with the County Recorder in Mineral County, Nevada, a receipt of the filing of said assessment work to be furnished the Owners through the escrow holder.

14. Purchasers shall pay all Federal, state, county, school and all other taxes, levies, assessments and charges that may be levied against said premises, the ores and products removed therefrom, and on all improvements placed by them on said property.

15. Purchasers agree to comply with all laws, both Federal and state, and the usual requirements of the State of Nevada regarding safeguards around mines, the Industrial Liability Insurance, the Workmen's Compensation Law of the State of Nevada, and the carrying on of all operations in a safe, sane and minerlike manner shall be met in all particulars.

16. Before commencing any work on said mining property, Purchasers agree to file and keep on file and of record in the Office of the County Recorder of Mineral County, Nevada, and to post and keep posted on said mining property, notices to the effect that said mining claims are being operated by them as Purchasers, as independent contractors, and no bills for labor or material furnished shall hold the property responsible in any way.

17. Inspection and free access to all parts of the property shall be available to any of the owners at any and all times.

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20. If any tonnage of ore is shipped from this property from the date of this instrument to July 1, 1952, or to the time of the first payment from Purchasers to Owners, a royalty of One ($1.00) Dollar a ton shall be paid, said royalty payments to be made to the Owners on the 15th day of the calendar month following

the month of removal thereof. Said payments shall be accompanied by way bill or weight receipt, together with a statement from the office of the company of purchasers of such tonnage products, as provided for the payment of other royalties hereunder.

21. Upon failure of Purchasers to comply with the conditions hereof, forfeiture of this Option to Purchase may be made on thirty (30) days' notice, in writing, by Owners to Purchasers, by registered mail, and all moneys theretofore paid to Owners shall be deemed forfeited and liquidated and Purchasers shall have thirty (30) days from the date of such notice to remove their equipment from said property.

22. The terms of the aforesaid Option to Purchase shall extend to and be binding upon all parties, and executors and administrators of all parties to the Option to Purchase.

23. The Purchasers shall have the right to patent the said mining claims at any time during the existence of this Option to Purchase. If it is before they may acquire title to the property, it is agreed that the property may be patented in the names of the Owners.

24. Time and compliance with the conditions above set forth are the essence of this Option to Purchase, and should the Purchasers fail to comply with, or violate any of the provisions herein, then at the option of the Owners, on written notice, as specified in Paragraph 21, above, this Option to Purchase shall terminate and be void and the Owners shall enter in and upon said mining claims and, using any and all necessary force, shall take possession and remove Purchasers, their employees and agents therefrom and, upon said doing, the Owners are hereby released from any and all liability in the premises.

25. The Owners of said claims agree to sign a subordination agreement as required by the Reconstruction Finance Corporation or other lending institution.

25. The tailings remaining on the mill site shall become the property of the owners in the event and at the time of default.

26. In the event of War, Strikes or an act of God, the time and conditions of this contract and agreement shall be extended by the length of such delay.

IN WITNESS WHEREOF, the parties hereto have hereunto set their hands the day and year first above written.

J. MALATESTA
JOE MALATESTA

E. FERRETTI
EUGENE FERRETTI

JOHN VUICH
JOHN VUICH

OWNERS

FRED FULKERSON
FRED FULKERSON

ROBERT B. HOLT
ROBERT B.HOLT

J. H. RODDA
J. H. RODDA

PURCHASERS

WITNESSES: WILLIAM REA

WITNESS: NEVA FERRETTI

ASSIGNMENT

The undersigned do hereby assign, transfer and set over unto FRED FULKERSON, ROBERT B. HOLT, J. H. RODDA, F. L. DiNAPOLI, JOS. P. PERRUCCI and JAMES F. BOCCARDO, in equal interests, all of their right, title and interest in and to the following Options to Purchase:

1. Option to Purchase dated January 1, 1952, by and between Joe Malatesta, Eugene Ferretti, and John Vuich, "owners", and Fred Fulkerson, Robert B. Holt, and J. H. Rodda, "Purchasers", covering Deep Mines Claims.

2. Option to Purchase, dated January 1, 1952, by and between Esther Rea, Joe Malatesta, and Eugene Ferretti, "owners", and Fred Fulkerson, Robert B. Holt, and J. H. Rodda, "Purchasers", covering Victory Claims.

3. Option to Purchase, dated January 1, 1952, by and between Esther Rea, Joe Malatesta, Eugene Ferretti and John Vuich, "Owners", and Fred Fulkerson, Robert B. Holt, and J. H. Rodda, "Purchasers", covering Bismark Mine Claims.

4. Option to Purchase, dated January 1, 1952, by and between Esther Rea and John Vuich, "Owners", and Fred Fulkerson, Robert B. Holt, and J. H. Rodda, "Purchasers", covering Green Talc Claims, Alto Mining Claim, and Green Talc Extension Claim.

DATED: April 9, 1952.

J. H. RODDA

FRED FULKERSON

ROBERT B. HOLT

OPERATING AGREEMENT

AGREEMENT MADE this 28th day of April, 1952, by and between FRED FULKERSON, ROBERT B. HOLT, J. H. RODDA, F. L. DiNAPOLI, JOS. P. PERRUCCI and JAMES F. BOCCARDO, hereinafter called Owners, and CORANDA CORPORATION, a corporation, hereinafter called Corporation,

W I T N E S S E T H:

WHEREAS, Owners are presently the owners and holders of certain options to purchase mining claims as follows:

1. Option to Purchase dated January 1, 1952, by and between Joe Malatesta, Eugene Ferretti, and John Vuich, "Owners", and Fred Fulkerson, Robert B. Holt and J. H. Rodda, "Purchasers", covering Deep Mines Claims.

2. Option to Purchase dated January 1, 1952, by and between Esther Rea, Joe Malatesta, and Eugene Ferretti, "Owners", and Fred Fulkerson, Robert B. Holt and J. H. Rodda, "Purchasers", covering Victory Claims.

3. Option to Purchase dated January 1, 1952, by and between Esther Rea, Joe Malatesta, and Eugene Ferretti and John Vuich, "Owners", and Fred Fulkerson, Robert B. Holt and J. H. Rodda, "Purchasers", covering Bismark Mine Claims.

4. Option to Purchase dated January 1, 1952, by and between Esther Rea and John Vuich, "Owners", and Fred Fulkerson, Robert B. Holt and J. H. Rodda, "Purchasers", covering Green Talc Claims, Alto Mining Claim and Green Talc Extension Claim.

WHEREAS, subsequent to the execution of the above-mentioned options to purchase, Fred Fulkerson, Robert B. Holt and J. H. Rodda executed an assignment of all their right, title and interest in and to said options to purchase to Fred Fulkerson, Robert B. Holt, J. H. Rodda, F. L. DiNapoli, Jos. P. Perrucci and James F. Boccardo, referred to as "Owners" herein, and

WHEREAS, Corporation desires to enter into an agreement with Owners whereby Corporation shall be permitted to explore, develop and operate said properties covered by said claims,

NOW, THEREFORE, it is mutually agreed as follows:

1. Owners hereby grant to Corporation, for a term of twenty-five (25) years, from and after date of execution hereof, the exclusive right to explore, develop, operate, mine and remove concentrates and minerals from all that certain mining property situate in the Gillis Range Mining District, County of Mineral, State of Nevada, covered by the above-mentioned claims, and the notices of locations of which are recorded in the Book of Mining Locations in the Office of the County Recorder of Mineral County, Hawthorne, Nevada, as follows:

Name of Claim	File Number	Date Discovered	Date Filed
Deep Mines	17079	10-28-25	11-16-25
Deep Mines No. 1	17080	10-28-25	11-16-25
Victory No. 1	35042	12-19-42	3-18-43
Victory No. 2	35043	12-19-42	3-18-43
Victory No. 3	35044	12-19-42	3-18-43
Victory No. 5	35045	12-28-42	3-18-43
Victory No. 6	35046	12-28-42	3-18-43
Bismark No. 1	25323	7-11-35	9-14-35
Bismark Mine	25324	7-11-35	9-14-35
Green Talc	20770	10- 5-29	1- 3-30
Green Talc No. 1	20771	10- 5-29	1- 3-30
Green Talc No. 2	20772	10- 5-29	1- 3-30
Green Talc No. 3	21342	6- 7-30	8-22-30
Green Talc No. 4	21343	6- 7-30	8-22-30
Alto Mining Claim	32460	6- 8-41	6- 8-41
Green Talc Extension	32498	6- 8-41	6- 8-41

2. As and for the consideration for the grant of the above listed rights, Corporation shall pay to Owners a sum equal to fifteen (15) percent of the gross selling price, f.o.b. cars or truck, plant of Corporation, on all concentrates, ore or minerals shipped from the said properties. Corporation guarantees to Owners that the minimum monthly payment to be made hereunder shall be the sum of One ($1.00) Dollar for each ton of concentrates, ore or minerals shipped from said properties, plus the sum of Six Hundred Fifty ($650.00) Dollars.

3. On the 15th day of each month, Corporation shall furnish to Owners a statement of a certified public accountant reflecting the gross sale price and tonnage of all concentrates, ore and minerals shipped from the said properties, accompanied by payment for all sums due to Owners for shipments made during the preceding month. The aforesaid payment shall be sent to such bank or banks or elsewhere as Corporation shall be directed by instructions from Owners during the existence of this agreement.

4. Corporation shall maintain full, complete and accurate records of all sales and shipments, ledgers, books of account, and other records and documents as may be necessary for Owners to ascertain their rights hereunder. Owners shall have the right to inspect all such records, documents and accounts of Corporation at any and all reasonable times, and be permitted to have said books of account, records, and documents audited by an auditor or certified public accountant of Owners' choice and selection at reasonable intervals, and Corporation shall furnish Owners full cooperation and reasonable assistance to facilitate any such audit.

5. All exploration, development, operation and production of the said mining property covered by said claims shall be

performed at the sole expense of Corporation, and Owners shall not be required to expend any sum in connection therewith. Corporation shall pay all Federal, state, county, school and all other taxes, levies, assessments and charges that may be levied against said mining properties, the ores and products removed therefrom, and on all improvements placed by Corporation on said properties.

6. Annual assessment work on said mining claims shall be done by Corporation for the year ending June 30, 1952, and each succeeding year during the term of this agreement, and said assessment work shall be recorded by Corporation before the 1st day of July of each year, with the County Recorder of Mineral County, Nevada, and a receipt of the filing of said assessment work shall be furnished by Corporation to Owners immediately thereafter.

7. Corporation shall comply with all laws, both Federal and state, and the usual requirements of the State of Nevada regarding safeguards around the mines, the Industrial Liability Insurance, the Workmen's Compensation Laws of the State of Nevada, and any other statute, law, ordinance or regulation dealing with the conduct of mining operations in a safe, sane and minerlike manner shall be met by Corporation in all particulars.

8. Before commencing any work on said mining property covered by the said claims, Corporation shall file and keep on file and of record in the Office of the County Recorder of Mineral County, Nevada, and to post and keep posted on said mining property, written notices to the effect that said mining claims are being operated by Corporation as an independent contractor, and that no bills for labor or materials furnished may be made a lien

against said property, and that no one other than Corporation shall be responsible for any obligations incurred for labor,materials, or otherwise, in the operation of said claims.

9. Owners shall have the right at any and all times to enter upon the property and all parts thereof to inspect same and any operating being conducted by Corporation in connection therewith.

10. Corporation agrees to work and operate said mining property in a minerlike fashion, it being understood that minerlike fashion shall consist of open-pit mining, tunneling, shaft work, or any other economical form of mining. It is understood that the ore and waste shall be placed on separate dumps if, for any reason, it is necessary that the same be stock-piled.

11. Upon termination of this agreement and the rights hereunder by mutual agreement of the parties, or otherwise, all buildings, structures and other permanent improvements installed upon the mining properties by Corporation shall, at the option of Owners, remain upon said property and be and belong to Owners. In the event that Owners desire the removal of any said building structure or permanent improvement at the termination of this agreement, Corporation shall remove the same at Corporation's sole expense.

12. The rights acquired by Corporation hereunder may not be assigned in whole or in part, nor may Corporation lease or sublease the whole or any part of the mining properties herein described, without first securing the consent of Owners in writing.

13. It is specifically understood that Corporation will make application to the Defense Minerals Administration for financial assistance in the exploration, development and operation of the said mining properties. In the event that the Defense Minerals Administration shall grant any financial assistance to Corporation

in any such form as shall be agreed upon between Corporation and the said Defense Minerals Administration, or other governmental agency of the United States, Owners shall execute any document required by the Defense Minerals Administration or other agency of the United States Government subordinating the interest of Owners in and to said mining property covered by the claims herein set forth, to the interest of the United States Government under any Exploration Project Contract, or any other agreement providing for financial assistance to Corporation by the United States Government. In addition to any others that Owners may be required to execute, they specifically agree to execute that certain subordination agreement entitled "Owner's Consent to Lien", a copy of which is attached hereto and marked "Exhibit A".

14. Tonnage of products removed from the properties shall be determined by way bill if shipped by railroad, or if shipped by other conveyance it shall be weighed by a licensed weight master, and copies of such way bills or weight receipts, together with a statement from Corporation of such tonnage products shall accompany the monthly payments to be made by Corporation to Owners, as hereinabove set forth.

15. Corporation will efficiently, promptly, and as soon as practicable, undertake all necessary exploration and development work upon said properties, and will thereafter commence and perform mining operations thereon and without unnecessary delay.

16. Corporation shall secure and maintain in full force and effect adequate policies of public liability and property damage insurance, and Workmen's Compensation Insurance, insuring Owners and Corporation from any and all claims, demands, suits or causes of action arising in favor of third persons as a result of

the operation of Corporation on the properties herein described, or by reason of the maintenance or condition of said properties.

17. In the event of war, strikes or an act of God, the time and conditions of this agreement shall be extended by the length of any delay or prevention of operations or production caused thereby.

18. Time is of the essence of this agreement, and in case of failure of Corporation, its successors or assigns, to make any of the payments herein provided or perform any of the covenants on its part, this agreement shall be forfeited and determined at the election of Owners. At the expiration of this agreement or the forfeiture of the same, Corporation will turn over to Owners all of the property acquired by Corporation from Owners hereunder. In the event of termination of this agreement, by reason of forfeiture as above set forth, Corporation, its successors and assigns shall forfeit all payments made by it on this agreement and all rights acquired hereunder, and such payments shall be retained by Owners, their heirs or assigns, as liquidated damages and they shall have the right to re-enter and take possession of said property and claims, and every part thereof. Upon the termination of this agreement, the tailings remaining on the millsite shall become the property of the Owners.

19. No part of this agreement shall be added to or taken from or amended in any way unless the same be in writing and attached to and made a part of this agreement, nor shall any verbal agreement pertaining hereto be of any binding force or effect or considered in any way or manner as a part of this agreement.

20. In the event of the bankruptcy of Corporation, or any assignment by Corporation, for the benefit of creditors, or otherwise, this agreement shall immediately cease and terminate

and no rights under this agreement shall inure to the benefit of any trustee in bankruptcy or assignee for the benefit of creditors.

21. As long as ore or minerals in paying quantities can be mined or produced from the properties covered by the claims herein set forth, Corporation shall not process or mill ore or minerals secured from mines or properties not included or covered by said claims set forth herein, in any plant or mill erected by Corporation for the original purpose of processing or milling the ore and minerals produced from the properties listed herein, without first securing the consent of Owners in writing.

22. Each and every clause of this agreement, and all the covenants and conditions contained herein, express or implied, shall extend to the successors, heirs, executors, administrators and lawful assigns of all the parties hereto.

IN WITNESS WHEREOF, the parties hereto have hereunto set their hands the day and year first above written.

F. H. Rodda

Robert B Hall

Fred Hulkerson

F. H. Rodda

[illegible]

James Boccardo

OWNERS

CORANDA CORPORATION, a corporation,

By F. H. Rodda
President

R B Hall
Secretary

CORPORATION

OWNER'S CONSENT TO LIEN

WHEREAS, the undersigned, as owner, co-owner, lessor, or seller has an interest in certain property in the State of Nevada, County of Mineral, which is the subject of a proposed Exploration Project Contract, hereinafter called the "Contract", between the United States of America, hereinafter called the "Government", and 1/ CORANDA CORPORATION, a Corporation,

_____

_____

hereinafter called the "Operator"; and

WHEREAS, under certain provisions of said Contract which are set forth on the reverse side hereof, the Government will acquire certain rights and equities which do or may conflict with or be adverse to the interest of the undersigned in said property;

NOW THEREFORE, the undersigned, in consideration of said Contract and as an inducement to the Government and Operator to enter into same, undertakes and agrees as follows:

1. The Government's equity in and right to remove facilities, buildings, fixtures, and equipment, as provided in the Contract, shall prevail over and be prior and superior to any conflicting or adverse rights of the undersigned.

2. The Government's percentage royalty on net smelter returns or other net proceeds realized from ore, concentrates, or metal produced within ten (10) years from the date of the Contract, and the Government's lien for the payment of said percentage royalty shall attach to the mineral deposit and the production therefrom, in the amount of the Government's contribution, not in excess of 2/ $_____, all upon the terms and conditions set forth in said Contract.

3. The undersigned shall commit no act nor assert any claim that may contravene or conflict with the lien, claim, or rights of the Government under the provisions of the said Contract. This agreement shall be binding upon the heirs, executors, administrators, successors, and assigns of the undersigned.

Dated this _____ day of _____, 195_.

_____

_____

_____

1/ Insert the name of the Operator as it will appear in the Exploration Project Contract.

2/ Insert the maximum amount of the Government's contribution.

10919

EXHIBIT A.

RELEVANT CONTRACT PROVISIONS

Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items costing more than $50 each, paid for or purchased with funds contributed jointly by the Operator and the Government, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the termination of the contract, if they have any salvage value, shall be disposed of for their joint account unless the Government, in writing, waives its interest in any such items. The Government may require the dismantling, severance from land, and removal of any such items in order to realize its interest in the salvage value thereof, and the cost of any such removal and of the disposal of the items shall be for the joint account of the parties in proportion to their respective interests.

Repayment by Operator. If, upon the completion of the exploration project or termination of the contract, the Government considers that a discovery or development has resulted from the work from which commercial production of ore may be made, the Government, within 6 months thereafter, shall so certify to the Operator, particularly describing and delimiting its estimate of the discovery or the development. Thereafter, if and as ore is produced as a result of such discovery or development, the Operator and his successor in interest shall be and become obligated to pay to the Government a percentage royalty on the net smelter returns or other net proceeds realized from such ore, concentrates, or metal produced within ten (10) years from the date of this contract, until the total amount contributed by the Government, without interest, is fully repaid or said 10 years have elapsed, whichever occurs first, as follows:

> Of net smelter returns or other net proceeds not in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent.
>
> Of net smelter returns or other net proceeds in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent, plus one-half (1/2) percent for each additional full fifty cents ($0.50) in excess of eight dollars ($8.00) per ton of ore, but not in excess of a maximum of five (5) percent.

This obligation to repay from net returns or proceeds shall be and remain a claim and lien upon the mineral deposit which is the subject of the exploration project and upon any production resulting from such discovery or development, in favor of the Government, until fully paid, or until said 10-year period has elapsed; and this claim and lien and the Government's right to repayment shall survive any termination of the contract, whether by completion of the exploration project or otherwise. This article is not to be construed as imposing any obligation on the Operator or his successor in interest to produce ore from any such discovery or development.

OWNER'S CONSENT TO LIEN

WHEREAS, the undersigned, as owner, co-owner, lessor, or seller has an interest in certain property in the State of Nevada, County of Mineral, which is the subject of a proposed Exploration Project Contract, hereinafter called the "Contract", between the United States of America, hereinafter called the "Government", and 1/ CORANDA CORPORATION, a corporation,

hereinafter called the "Operator"; and

WHEREAS, under certain provisions of said Contract which are set forth on the reverse side hereof, the Government will acquire certain rights and equities which do or may conflict with or be adverse to the interest of the undersigned in said property;

NOW THEREFORE, the undersigned, in consideration of said Contract and as an inducement to the Government and Operator to enter into same, undertakes and agrees as follows:

1. The Government's equity in and right to remove facilities, buildings, fixtures, and equipment, as provided in the Contract, shall prevail over and be prior and superior to any conflicting or adverse rights of the undersigned.

2. The Government's percentage royalty on net smelter returns or other net proceeds realized from ore, concentrates, or metal produced within ten (10) years from the date of the Contract, and the Government's lien for the payment of said percentage royalty shall attach to the mineral deposit and the production therefrom, in the amount of the Government's contribution, not in excess of 2/ $200,000.00, all upon the terms and conditions set forth in said Contract.

3. The undersigned shall commit no act nor assert any claim that may contravene or conflict with the lien, claim, or rights of the Government under the provisions of the said Contract. This agreement shall be binding upon the heirs, executors, administrators, successors, and assigns of the undersigned.

Dated this 28th day of April, 1952.

J. H. Rodda
R B Hall
Fred Fulkerson

1/ Insert the name of the Operator as it will appear in the Exploration Project Contract.

2/ Insert the maximum amount of the Government's contribution.

10919

RELEVANT CONTRACT PROVISIONS

Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items costing more than $50 each, paid for or purchased with funds contributed jointly by the Operator and the Government, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the termination of the contract, if they have any salvage value, shall be disposed of for their joint account unless the Government, in writing, waives its interest in any such items. The Government may require the dismantling, severance from land, and removal of any such items in order to realize its interest in the salvage value thereof, and the cost of any such removal and of the disposal of the items shall be for the joint account of the parties in proportion to their respective interests.

Repayment by Operator. If, upon the completion of the exploration project or termination of the contract, the Government considers that a discovery or development has resulted from the work from which commercial production of ore may be made, the Government, within 6 months thereafter, shall so certify to the Operator, particularly describing and delimiting its estimate of the discovery or the development. Thereafter, if and as ore is produced as a result of such discovery or development, the Operator and his successor in interest shall be and become obligated to pay to the Government a percentage royalty on the net smelter returns or other net proceeds realized from such ore, concentrates, or metal produced within ten (10) years from the date of this contract, until the total amount contributed by the Government, without interest, is fully repaid or said 10 years have elapsed, whichever occurs first, as follows:

Of net smelter returns or other net proceeds not in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent.

Of net smelter returns or other net proceeds in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent, plus one-half (1/2) percent for each additional full fifty cents ($0.50) in excess of eight dollars ($8.00) per ton of ore, but not in excess of a maximum of five (5) percent.

This obligation to repay from net returns or proceeds shall be and remain a claim and lien upon the mineral deposit which is the subject of the exploration project and upon any production resulting from such discovery or development, in favor of the Government, until fully paid, or until said 10-year period has elapsed; and this claim and lien and the Government's right to repayment shall survive any termination of the contract, whether by completion of the exploration project or otherwise. This article is not to be construed as imposing any obligation on the Operator or his successor in interest to produce ore from any such discovery or development.

STATE OF NEVADA,

County of Mineral } ss.

On this 24th *day of* April *A. D. one thousand nine hundred and* fifty two *personally appeared before me,* J. J. Connelly *a Notary Public in and for the said County of* Mineral

Esther Rea, E. Ferretti, Joe Malatesta and John Vuich

*known to me to be the person*s *described in and who executed the foregoing instrument, who acknowledged to me that* t*he*y *executed the same freely and voluntarily and for the uses and purposes therein mentioned.*

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the County of Mineral*, the day and year in this certificate first above written.*

My Comm. Exp. June 10, 1954

J. J. Connelly

Notary Public in and for the County of Mineral*, State of Nevada.*

Carlisle's Form No. 84N—(Acknowledgement General)

OWNER'S CONSENT TO LIEN

WHEREAS, the undersigned, as owner, co-owner, lessor, or seller has an interest in certain property in the State of Nevada, County of Mineral, which is the subject of a proposed Exploration Project Contract, hereinafter called the "Contract", between the United States of America, hereinafter called the "Government", and 1/ CORANDA CORPORATION, a corporation,

hereinafter called the "Operator"; and

WHEREAS, under certain provisions of said Contract which are set forth on the reverse side hereof, the Government will acquire certain rights and equities which do or may conflict with or be adverse to the interest of the undersigned in said property;

NOW THEREFORE, the undersigned, in consideration of said Contract and as an inducement to the Government and Operator to enter into same, undertakes and agrees as follows:

1. The Government's equity in and right to remove facilities, buildings, fixtures, and equipment, as provided in the Contract, shall prevail over and be prior and superior to any conflicting or adverse rights of the undersigned.

2. The Government's percentage royalty on net smelter returns or other net proceeds realized from ore, concentrates, or metal produced within ten (10) years from the date of the Contract, and the Government's lien for the payment of said percentage royalty shall attach to the mineral deposit and the production therefrom, in the amount of the Government's contribution, not in excess of 2/ $200,000.00, all upon the terms and conditions set forth in said Contract.

3. The undersigned shall commit no act nor assert any claim that may contravene or conflict with the lien, claim, or rights of the Government under the provisions of the said Contract. This agreement shall be binding upon the heirs, executors, administrators, successors, and assigns of the undersigned.

Dated this 24th day of April, 1952.

Esther Rea
E. Garrett
Geo Malatesta
John Vuich

1/ Insert the name of the Operator as it will appear in the Exploration Project Contract.

2/ Insert the maximum amount of the Government's contribution.

10919

RELEVANT CONTRACT PROVISIONS

Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items costing more than $50 each, paid for or purchased with funds contributed jointly by the Operator and the Government, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the termination of the contract, if they have any salvage value, shall be disposed of for their joint account unless the Government, in writing, waives its interest in any such items. The Government may require the dismantling, severance from land, and removal of any such items in order to realize its interest in the salvage value thereof, and the cost of any such removal and of the disposal of the items shall be for the joint account of the parties in proportion to their respective interests.

Repayment by Operator. If, upon the completion of the exploration project or termination of the contract, the Government considers that a discovery or development has resulted from the work from which commercial production of ore may be made, the Government, within 6 months thereafter, shall so certify to the Operator, particularly describing and delimiting its estimate of the discovery or the development. Thereafter, if and as ore is produced as a result of such discovery or development, the Operator and his successor in interest shall be and become obligated to pay to the Government a percentage royalty on the net smelter returns or other net proceeds realized from such ore, concentrates, or metal produced within ten (10) years from the date of this contract, until the total amount contributed by the Government, without interest, is fully repaid or said 10 years have elapsed, whichever occurs first, as follows:

Of net smelter returns or other net proceeds not in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent.

Of net smelter returns or other net proceeds in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent, plus one-half (1/2) percent for each additional full fifty cents ($0.50) in excess of eight dollars ($8.00) per ton of ore, but not in excess of a maximum of five (5) percent.

This obligation to repay from net returns or proceeds shall be and remain a claim and lien upon the mineral deposit which is the subject of the exploration project and upon any production resulting from such discovery or development, in favor of the Government, until fully paid, or until said 10-year period has elapsed; and this claim and lien and the Government's right to repayment shall survive any termination of the contract, whether by completion of the exploration project or otherwise. This article is not to be construed as imposing any obligation on the Operator or his successor in interest to produce ore from any such discovery or development.

STATE OF NEVADA,
COUNTY OF MINERAL, SS.

On this 24th day of April A.D. one thousand nine hundred an fifty two, personally appeared before me, J. J. Connelly a Notary Public in and for the said County of Mineral Esther Rea and John Vuich known to me to be the persons described in and who executed the foregoing instrument, who acknowledged to me that they executed the same freely and voluntarily, and for the uses and purposes therein mentioned.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the County of Mineral, the day and year in this certificate first above written.

J. J. Connelly

J. J. CONNELLY
Notary Public in and for the County of Mineral, State of Nevada.

My Comm. Expires June 10, 1954.

OWNER'S CONSENT TO LIEN

WHEREAS, the undersigned, as owner, co-owner, lessor, or seller has an interest in certain property in the State of Nevada, County of Mineral, which is the subject of a proposed Exploration Project Contract, hereinafter called the "Contract", between the United States of America, hereinafter called the "Government", and 1/ Coranda Corporation, a corporation,

hereinafter called the "Operator"; and

WHEREAS, under certain provisions of said Contract which are set forth on the reverse side hereof, the Government will acquire certain rights and equities which do or may conflict with or be adverse to the interest of the undersigned in said property;

NOW THEREFORE, the undersigned, in consideration of said Contract and as an inducement to the Government and Operator to enter into same, undertakes and agrees as follows:

1. The Government's equity in and right to remove facilities, buildings, fixtures, and equipment, as provided in the Contract, shall prevail over and be prior and superior to any conflicting or adverse rights of the undersigned.

2. The Government's percentage royalty on net smelter returns or other net proceeds realized from ore, concentrates, or metal produced within ten (10) years from the date of the Contract, and the Government's lien for the payment of said percentage royalty shall attach to the mineral deposit and the production therefrom, in the amount of the Government's contribution, not in excess of 2/ $200,000.00, all upon the terms and conditions set forth in said Contract.

3. The undersigned shall commit no act nor assert any claim that may contravene or conflict with the lien, claim, or rights of the Government under the provisions of the said Contract. This agreement shall be binding upon the heirs, executors, administrators, successors, and assigns of the undersigned.

Dated this 24th day of April, 1952.

Esther Rea

John Vucich

1/ Insert the name of the Operator as it will appear in the Exploration Project Contract.

2/ Insert the maximum amount of the Government's contribution.

10919

RELEVANT CONTRACT PROVISIONS

Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items costing more than $50 each, paid for or purchased with funds contributed jointly by the Operator and the Government, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the termination of the contract, if they have any salvage value, shall be disposed of for their joint account unless the Government, in writing, waives its interest in any such items. The Government may require the dismantling, severance from land, and removal of any such items in order to realize its interest in the salvage value thereof, and the cost of any such removal and of the disposal of the items shall be for the joint account of the parties in proportion to their respective interests.

Repayment by Operator. If, upon the completion of the exploration project or termination of the contract, the Government considers that a discovery or development has resulted from the work from which commercial production of ore may be made, the Government, within 6 months thereafter, shall so certify to the Operator, particularly describing and delimiting its estimate of the discovery or the development. Thereafter, if and as ore is produced as a result of such discovery or development, the Operator and his successor in interest shall be and become obligated to pay to the Government a percentage royalty on the net smelter returns or other net proceeds realized from such ore, concentrates, or metal produced within ten (10) years from the date of this contract, until the total amount contributed by the Government, without interest, is fully repaid or said 10 years have elapsed, whichever occurs first, as follows:

> Of net smelter returns or other net proceeds not in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent.
>
> Of net smelter returns or other net proceeds in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent, plus one-half (1/2) percent for each additional full fifty cents ($0.50) in excess of eight dollars ($8.00) per ton of ore, but not in excess of a maximum of five (5) percent.

This obligation to repay from net returns or proceeds shall be and remain a claim and lien upon the mineral deposit which is the subject of the exploration project and upon any production resulting from such discovery or development, in favor of the Government, until fully paid, or until said 10-year period has elapsed; and this claim and lien and the Government's right to repayment shall survive any termination of the contract, whether by completion of the exploration project or otherwise. This article is not to be construed as imposing any obligation on the Operator or his successor in interest to produce ore from any such discovery or development.

STATE OF NEVADA,

County of Mineral } ss.

On this 24 day of April A. D. one thousand nine hundred and 1952

personally appeared before me, J. J. Connelly a Notary Public in and

for the said County of Mineral

Esther Rea, Joe Malatesta, E. Ferretti

known to me to be the persons described in and who executed the foregoing instrument, who acknowledged to me that they executed the same freely and voluntarily and for the uses and purposes therein mentioned.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the County of Mineral, the day and year in this certificate first above written.

J. J. Connelly

Notary Public in and for the County of Mineral, State of Nevada.

My Commission Expires June 10, 1954.

Carlisle's Form No. 34N—(Acknowledgement General)

OWNER'S CONSENT TO LIEN

WHEREAS, the undersigned, as owner, co-owner, lessor, or seller has an interest in certain property in the State of Nevada, County of Mineral, which is the subject of a proposed Exploration Project Contract, hereinafter called the "Contract", between the United States of America, hereinafter called the "Government", and 1/ Coranda Corporation, a corporation,

hereinafter called the "Operator"; and

WHEREAS, under certain provisions of said Contract which are set forth on the reverse side hereof, the Government will acquire certain rights and equities which do or may conflict with or be adverse to the interest of the undersigned in said property;

NOW THEREFORE, the undersigned, in consideration of said Contract and as an inducement to the Government and Operator to enter into same, undertakes and agrees as follows:

1. The Government's equity in and right to remove facilities, buildings, fixtures, and equipment, as provided in the Contract, shall prevail over and be prior and superior to any conflicting or adverse rights of the undersigned.

2. The Government's percentage royalty on net smelter returns or other net proceeds realized from ore, concentrates, or metal produced within ten (10) years from the date of the Contract, and the Government's lien for the payment of said percentage royalty shall attach to the mineral deposit and the production therefrom, in the amount of the Government's contribution, not in excess of 2/ $ 200,000.00, all upon the terms and conditions set forth in said Contract.

3. The undersigned shall commit no act nor assert any claim that may contravene or conflict with the lien, claim, or rights of the Government under the provisions of the said Contract. This agreement shall be binding upon the heirs, executors, administrators, successors, and assigns of the undersigned.

Dated this 24th day of April, 1952.

Walter Rea

Jay Malatesta

E. Ferretti

1/ Insert the name of the Operator as it will appear in the Exploration Project Contract.

2/ Insert the maximum amount of the Government's contribution.

10919

RELEVANT CONTRACT PROVISIONS

Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items costing more than $50 each, paid for or purchased with funds contributed jointly by the Operator and the Government, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the termination of the contract, if they have any salvage value, shall be disposed of for their joint account unless the Government, in writing, waives its interest in any such items. The Government may require the dismantling, severance from land, and removal of any such items in order to realize its interest in the salvage value thereof, and the cost of any such removal and of the disposal of the items shall be for the joint account of the parties in proportion to their respective interests.

Repayment by Operator. If, upon the completion of the exploration project or termination of the contract, the Government considers that a discovery or development has resulted from the work from which commercial production of ore may be made, the Government, within 6 months thereafter, shall so certify to the Operator, particularly describing and delimiting its estimate of the discovery or the development. Thereafter, if and as ore is produced as a result of such discovery or development, the Operator and his successor in interest shall be and become obligated to pay to the Government a percentage royalty on the net smelter returns or other net proceeds realized from such ore, concentrates, or metal produced within ten (10) years from the date of this contract, until the total amount contributed by the Government, without interest, is fully repaid or said 10 years have elapsed, whichever occurs first, as follows:

Of net smelter returns or other net proceeds not in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent.

Of net smelter returns or other net proceeds in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent, plus one-half (1/2) percent for each additional full fifty cents ($0.50) in excess of eight dollars ($8.00) per ton of ore, but not in excess of a maximum of five (5) percent.

This obligation to repay from net returns or proceeds shall be and remain a claim and lien upon the mineral deposit which is the subject of the exploration project and upon any production resulting from such discovery or development, in favor of the Government, until fully paid, or until said 10-year period has elapsed; and this claim and lien and the Government's right to repayment shall survive any termination of the contract, whether by completion of the exploration project or otherwise. This article is not to be construed as imposing any obligation on the Operator or his successor in interest to produce ore from any such discovery or development.

STATE OF NEVADA,

County of Mineral } ss.

On this 24th *day of* April *A. D. one thousand nine hundred and* fifty two

personally appeared before me, J. J. Connelly *a Notary Public in and*

for the said County of Mineral

E. Ferretti, Joe Malatesta and John Vuich

*known to me to be the person*s *described in and who executed the foregoing instrument, who acknowledged to me that* they *executed the same freely and voluntarily and for the uses and purposes therein mentioned.*

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the County of Mineral*, the day and year in this certificate first above written.*

My Comm. Exp. June 10, 1954

J. J. Connelly

Notary Public in and for the County of Mineral*, State of Nevada.*

Carlisle's Form No. 34N—(Acknowledgement General)

OWNER'S CONSENT TO LIEN

WHEREAS, the undersigned, as owner, co-owner, lessor, or seller has an interest in certain property in the State of Nevada, County of Mineral, which is the subject of a proposed Exploration Project Contract, hereinafter called the "Contract", between the United States of America, hereinafter called the "Government", and 1/ CORANDA CORPORATION, a corporation,

hereinafter called the "Operator"; and

WHEREAS, under certain provisions of said Contract which are set forth on the reverse side hereof, the Government will acquire certain rights and equities which do or may conflict with or be adverse to the interest of the undersigned in said property;

NOW THEREFORE, the undersigned, in consideration of said Contract and as an inducement to the Government and Operator to enter into same, undertakes and agrees as follows:

1. The Government's equity in and right to remove facilities, buildings, fixtures, and equipment, as provided in the Contract, shall prevail over and be prior and superior to any conflicting or adverse rights of the undersigned.

2. The Government's percentage royalty on net smelter returns or other net proceeds realized from ore, concentrates, or metal produced within ten (10) years from the date of the Contract, and the Government's lien for the payment of said percentage royalty shall attach to the mineral deposit and the production therefrom, in the amount of the Government's contribution, not in excess of 2/ $ 200,000.00, all upon the terms and conditions set forth in said Contract.

3. The undersigned shall commit no act nor assert any claim that may contravene or conflict with the lien, claim, or rights of the Government under the provisions of the said Contract. This agreement shall be binding upon the heirs, executors, administrators, successors, and assigns of the undersigned.

Dated this 24th day of April, 1952

E. Ferretti

Joe Calabresta

John Vuich

1/ Insert the name of the Operator as it will appear in the Exploration Project Contract.

2/ Insert the maximum amount of the Government's contribution.

10919

RELEVANT CONTRACT PROVISIONS

Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items costing more than $50 each, paid for or purchased with funds contributed jointly by the Operator and the Government, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the termination of the contract, if they have any salvage value, shall be disposed of for their joint account unless the Government, in writing, waives its interest in any such items. The Government may require the dismantling, severance from land, and removal of any such items in order to realize its interest in the salvage value thereof, and the cost of any such removal and of the disposal of the items shall be for the joint account of the parties in proportion to their respective interests.

Repayment by Operator. If, upon the completion of the exploration project or termination of the contract, the Government considers that a discovery or development has resulted from the work from which commercial production of ore may be made, the Government, within 6 months thereafter, shall so certify to the Operator, particularly describing and delimiting its estimate of the discovery or the development. Thereafter, if and as ore is produced as a result of such discovery or development, the Operator and his successor in interest shall be and become obligated to pay to the Government a percentage royalty on the net smelter returns or other net proceeds realized from such ore, concentrates, or metal produced within ten (10) years from the date of this contract, until the total amount contributed by the Government, without interest, is fully repaid or said 10 years have elapsed, whichever occurs first, as follows:

Of net smelter returns or other net proceeds not in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent.

Of net smelter returns or other net proceeds in excess of eight dollars ($8.00) per ton of ore: One and one-half (1-1/2) percent, plus one-half (1/2) percent for each additional full fifty cents ($0.50) in excess of eight dollars ($8.00) per ton of ore, but not in excess of a maximum of five (5) percent.

This obligation to repay from net returns or proceeds shall be and remain a claim and lien upon the mineral deposit which is the subject of the exploration project and upon any production resulting from such discovery or development, in favor of the Government, until fully paid, or until said 10-year period has elapsed; and this claim and lien and the Government's right to repayment shall survive any termination of the contract, whether by completion of the exploration project or otherwise. This article is not to be construed as imposing any obligation on the Operator or his successor in interest to produce ore from any such discovery or development.

Question 2 (a)

The principal commercial minerals expected to be found in the four groups of claims are Corundum, Andalusite and similar refractory minerals.

Question 2 (b)

The Green Talc, Victory and Bismark deposits located on the slope of the Gillis Range appear to be along the same structural line, and are probably of the same geologic age and origin. The Deep Mine deposit appears to be independent of the other three, but of similar mineralization. In general, the deposits are found in highly metamorphosed rocks derived from sediments originally and these have been altered to schist, gneiss, quartzite and slates. The Deep Mine deposit is near a granatic contact, which evidently exercises some structural control on the deposit. In the cursory examination of the other three deposits nothing could be determined of their probable origin at this time. A thorough geologic study will have to be made of the area in conjunction with the diamond drilling program, after which the details of the origin of these deposits may be clarified.

War Minerals Report No. 388 (Preliminary Pilot Plant Concentration of Andalusite and Corundum Ore from the Vicinity of Hawthorne, Nevada) is the report of the most extensive work done on the property to date. (Copy attached)

ALTO AND GREEN TALC CLAIM GROUP:

Within this claim group there are several prominent outcrops containing Andalusite, Corundum and other refractory minerals. The largest of these outcrops is approximately 950 feet long and averages over 200 feet in width, in a roughly rectangular shape. In addition to this large exposure there are at least five smaller exposures nearby. These ore bearing bodies are in general in a roughly oval shape at the outcrop, and they are enclosed in a highly metamorphosed country rock, made up of schist, gneiss and quartzite. In addition, there are several outcrops of dike material nearby. It is proposed to explore these structures by diamond drill holes to be located approximately as shown on the accompanying map.

BISMARK GROUP:

Within these claims, approximately 100 feet North of the point occupied by their mutual No. 1 corners, is an ore bearing outcrop measuring approximately 275 feet by 250 feet in a roughly square form. This outcrop is enclosed in quartzite, schist and gneiss rocks. The apparent structure controlling the intrusive ore body appears to extend along

Question 2 (b) Cont'd

an axis running about NE-SW, in which case there would be possible extensions of the ore body along this axis beyond the visible outcrops, and it is proposed to explore these possible extensions by diamond drill holes, as shown on the accompanying map. There are several trenches and pits exposing ore within this outcrop area.

DEEP MINES GROUP:

Within these claims, approximately on the mutual boundary line, is an ore bearing outcrop measuring approximately 350 feet by 450 feet in a roughly circular form. This outcrop is enclosed in quartzites and schists. There are several trenches and pits exposing ore within this outcrop area. It is proposed to explore this ore body by diamond drill holes to be located approximately as shown on the accompanying map.

VICTORY CLAIMS GROUP:

These claims extend from approximately the middle quarter of Section 26, Township 9 North Range 31 East in an easterly direction to approximately the middle of the Northeast quarter of Section 25, Township North Range 31 East, a total distance of approximately 7800 feet. Within these claims are numerous pieces of float composed of ores containing Andalusite and Corundum, along with other refractory minerals, which appear to be of commercial grade. Also, within these claims are several small outcrops of undetermined extension. These claims lie approximately six miles slightly North of East of the town of Thorne, Nevada, and lie on the southerly slope of the Gillis Range of hills. With the exception of a number of shallow pits and trenches, no extensive prospecting has been done. It would be necessary to trace the float showing up these slopes and to prospect the surface alluvial materials with bulldozer trenches, followed up by diamond drilling in the favorable areas which might be disclosed. As an estimate of the amount of diamond drilling necessary, it is assumed that approximately 8 holes of 350 feet depth, laid out in an approximate North-South direction perpendicular to the apparent strike of the structures, would be needed to explore this area. It is hoped that with this work, additional ore bodies of commercial grade of Andalusite, Corundum and related minerals will be disclosed.

Question 3 (a)

Outline of Proposed Exploratory Diamond Drilling

ALTO AND GREEN TALC CLAIM GROUP:

It is proposed to drill approximately 8400 feet of diamond drill holes with approximately 21 different holes, whose location is indicated on the attached map. These drill holes should outline the ore bodies in sufficient detail to make close estimates of the tonnage of ore available in this area. Holes No. 1 through 9 and 19, 20 and 21 are inclined holes of varying degrees of from 30 to 60 degrees between 500 and 600 feet in depth. The balance of the holes will be vertical to supplement the information derived from the inclined holes. Also, trenching and some bulldozer cuts may be made. It appears from the outcrops that this area will be one of the most promising for possible ore deposits, from information which we have at the present time. It is believed that a considerable tonnage of good ore can be developed in this area.

BISMARK GROUP:

It is proposed to drill approximately 3500 feet of drill holes within this group, so as to disclose the extensions of the known structures containing ore bodies. Holes 1, 4, 5 and 6 will be drilled to approximately 400 feet in depth at strike approximately N45°00'W, which is perpendicular to the apparent strike of the structures. These holes will be inclined approximately 45 degrees from the vertical, to cross cut the expected ore bodies at depth. Holes 2, 3, 7, 8, 9 and 10 will be drilled vertical to indicate the possible extension of the structures at depth. The holes will be drilled in the approximate order of their numbers, depending on the information disclosed as the work progresses.

DEEP MINES GROUP:

It is proposed that approximately 2500 feet of drill holes be located as indicated on the accompanying map to test the known structure for tonnage and value. Holes 1, 4 and 5 will be drilled on a strike of approximately N40°00'W, with an approximate inclination of 45 degrees from the vertical. The collar of these holes will be located approximately 50 feet from the road at the base of the hill. Holes 2, 3, 6 and 7 will be vertical holes going down to an approximate depth of 250 feet each to help outline the vertical extent of the known structure. The exact location and extent of these holes must be determined from

Question 3 (a) Cont'd

the progressive results obtained as they are drilled. Thus, if hole No. 1 should prove that the indicated outcrop of ore extends downward with the approximate outlines as it shows on the surface, then holes 2 and 3 will be put down to determine its vertical extent to the expected commercial mining limits. Should these holes prove the ore to be extensive, then holes 4 and 5 will be drilled to see if the ore body extends to the Northeast or Southwest of the known outcrop. Should either one or both of these holes cut commercial ore, then holes 6 and 7 will be drilled to determine the vertical extent of the structure as indicated. In this manner, the diamond drilling program will be extended to enlarge the known ore bodies.

VICTORY GROUP:

These claims extend from approximately the middle quarter of Section 26, Township 9 North Range 31 East in an easterly direction to approximately the middle of the Northeast quarter of Section 25, Township North Range 31 East, a total distance of approximately 7300 feet. Within these claims are numerous pieces of float composed of ores containing Andalusite and other refractory minerals, which appear to be of commercial grade. Also, within these claims are several small outcrops of undetermined extension. These claims lie approximately six miles slightly North of East of the town of Thorne, Nevada, and lie on the southerly slope of the Gillis Range of hills. With the exception of a number of shallow pits and trenches, no extensive prospecting has been done. It would be necessary to trace the float showing up these slopes and to prospect the surface alluvial materials with bulldozer trenches, followed up by diamond drilling in the favorable areas which might be disclosed. As an estimate of the amount of diamond drilling necessary, it is assumed that approximately 8 holes of 350 feet depth, laid out in an approximate North-South direction perpendicular to the apparent strike of the structures, would be needed to explore this area. It is hoped that with this work, additional ore bodies of commercial grade of Andalusite, Corundum and related minerals will be disclosed.

See attached cost estimates which give the cost of the project.

Question 3 (b)

The diamond drilling program can be started within ten days following the approval of the exploration, and it is estimated that it will be completed within 90 days.

Question 4

Covered by maps.

Question 5

No existing facilities or buildings are available on the property.

Question 6

It is estimated that it will cost about $500.00 to condition temporary office space in Hawthorne.

It is estimated that a core storage building 14'x60'x8' with provisions for core bins would cost $3200.

Question 7 (a)

Operating equipment to be rented:

Compressor, Jack Hammer and Equipment (Rental purchase option)	$ 250.00 mo.
Office Space	50.00 mo.
Laboratory Space.	50.00 mo.
Typewriter and calculating machine. . .	35.00 mo.

Question 7 (b)

Operating equipment to be purchased:

Transit, Stadia Rod, Chain and miscellaneous survey items	$ 500.00
Sampling (Diamond Saw) and General Mining Tools	600.00
Mineral Testing and Laboratory Equipment (Crusher, Grinder, Glassware, Balance and Miscellaneous Equipment).	3,000.00
Jeep	1,000.00

Question 7 (c)

Operating equipment furnished by us:

Reconnaissance Car - Depreciation (3 months)	$ 95.00

Question 8

General Superintendent (1).	$750.00 mo.
Chief Engineer (1)	750.00 "
Geologist (housing to be furnished) (1) .	750.00 "
Surveyor (1)	500.00 "
Asst. Engineer (1).	500.00 "
Chemist (1)	400.00 "
Technician (1).	300.00 "
Assistant to Technician (1)	275.00 "
Core Pickers (2 per shift).	275.00 "
Miners (4 per shift).	325.00 "
Muckers (8 per shift)	275.00 "
Stenographer (1)	300.00 "

NOTE: Personnel requirements are based on two shifts per day.

Question 9

Supplies:

Core boxes - 600 @ $7.50.	$ 4,500.00
Office Supplies	250.00
Sampling Container.	100.00
Explosives for Sampling	100.00
Laboratory Supplies	500.00
Blasting Supplies (Mining).	1,500.00
Drilling Supplies . . . . . (Steel, Repairs, Parts and Fuel)	450.00
Transportation Supplies and Repairs . . .	550.00
Drafting Supplies	75.00

Engineering:

Accounted for under Question 8.

Assaying:

To be performed by Pittsburg Testing Laboratories 30,000.00
See attached sheets concerning detail costs.

Accounting: 1,000.00

Power: None

Water:

Hauling and supplying water to crew - $5.00 per day 450.00

Utilities:

Telephone and Communications-$200 per mo.	600.00
Electric Power for Laboratory and Office-$10 per mo.	30.00

Drafting Equipment:

Table and Chairs	75.00
Instruments	50.00

Office Equipment:

Desk, Standard	35.00
Small desks (2).	40.00
Swivel Chairs (2).	30.00
Typewriter table and chair	40.00
Filing Cabinet	75.00
Miscellaneous	30.00

Question 10 (a)

$20,000.00

Question 10 (b)

Yes

Question 11

The area is typically arid with very light rainfall, typical of this Nevada area. The country is barren of any vegetation, with the exception of some small desert brush. It is reported that good water is available in abundance from wells drilled in the bottom of the valley.

There is an adequate amount of local labor available in the small nearby towns along the railway and the highways.

This will be a year around operation as the climatic conditions are favorable.

State and county roads and a branch of the Southern Pacific Railroad serve this area and pass within a few miles of the properties. Secondary roads connect and serve the different claim groups.

It is proposed to run two shifts during this exploration period so that information necessary for the proposed mill and mine operations can be obtained with the least possible delay. It will therefore require more supervision than would ordinarily be necessary for this exploration period.

The location and extent of hand trenching, crosscuts, shafts and prospect pits will be determined from the results of detailed geological studies of the formations exposed as the exploration work progresses. Therefore, there is no definite location assigned to such work in this report. The expected costs are taken in account under miners' wages, blasting supplies, etc.

Supplemental Information

EXPLORATION COST ESTIMATES

Item	Quantity	Unit Cost	Total
Diamond Drilling -- (Contracted) (See attached letter of proposal)	17,000 ft.	$6.50/ft.	$110,500
Core and sludge analysis See attached proposal-	each		
Class I		$14.00	
" II		17.00	
" III		25.00	
" IV		50.00	
" V		15.00	30,000
Conditioning Office Building			500
Core Storage Building 14'x60'			3,200
Operating Equipment			
Rented			
Compressor-Jackhammer and equipment	1 complete unit	$250.00/mo.	750.00
Office Space	1	$50.00/mo.	150.00
Laboratory Space	1	$50.00/mo.	150.00
Typewriter-Calculator	1 ea.	$35.00/mo.	105.00
Purchased			
Transit, Stadia, Chain and misc. equipment			500.00
Sampling Equipment, Diamond Saw and General Mining Tools			600.00
Laboratory Equipment-Crushers, Grinders, Balances & misc.			3,000.00
Jeep-Field Car			1,000.00
Drafting Equipment -			
Table and chair	1 ea.		75.00
Instruments			50.00
Office Equipment -			
Standard Desk	1		35.00
Small Desks	2		40.00
Swivel Chairs	2		30.00
Typist's Table and chair	1 ea.		40.00
Filing Cabinet	1		75.00
Misc.			30.00

ANSWER SHEET FOR FORM MF-103 -- PAGE 18

Supplemental Information - Exploration Cost Estimates

Item	Quantity	Unit Cost	Total
Operation Equipment			
Furnished by Applicant			
Reconnaissance Car- Depreciation 3 mos.			$ 95.00
Supplies			
Core Boxes	600	$7.50/bx	4,500.00
Office Supplies			250.00
Sampling Containers			100.00
Explosives for Sampling			500.00
Blasting Supplies for mining			1,500.00
Laboratory Supplies			500.00
Drill Steel, Repair Parts, Fuel and Lubricants			450.00
Transportation Supplies and Repairs			550.00
Drafting Supplies			75.00
Engineering			
Accounted for under operating personnel			
Accounting			1,000.00
Power - None			
General			
Hauling and supplying water to crew		$5.00/day	450.00
Utilities			
Telephone and Communications		$200/mo.	600.00
Electric Power for Laboratory and Office		$10/mo.	30.00
Operating Personnel - Four months			
General Superintendent		$750/mo.	3,000.00
Chief Engineer		$750/mo.	3,000.00
Geologist - $750 plus housing		$800/mo.	3,200.00
Assistant Engineer		$500/mo.	2,000.00
Surveyor		$500/mo.	2,000.00
Chemist		$400/mo.	1,600.00
Technician		$300/mo.	1,200.00
Assistant to Technician		$275/mo.	1,100.00

ANSWER SHEET FOR FORM MF-103 -- PAGE 19

Supplemental Information - Exploration Cost Estimates

Item	Quantity	Unit Cost	Total
Labor - Four Months			
Core Pickers (3 mos. only)	4 (2 per shift)	$275/mo.	$ 3,300.00
Miners	4 (2 per shift)	$325/mo.	5,200.00
Muckers	8 (4 per shift)	$275/mo.	8,800.00
Stenographer		$300/mo.	1,200.00
Miscellaneous Costs			2,970.00
			$200,000.00

orm MF-100
(May 1951)

U. S. DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION

Form approved.
Budget Bureau No. 42-R1026.

GENERAL TECHNICAL DATA
FOR USE UNDER THE
DEFENSE PRODUCTION ACT OF 1950

NOT TO BE FILLED IN BY APPLICANT

Docket No. DMEA-2512

Date received 5-5-52

CORANDA CORPORATION
386 - RACE STREET
SAN JOSE, CALIFORNIA

Name and address of applicant

Date April 29, 1952

INSTRUCTIONS

This form is to be filed with Defense Minerals Administration, Department of the Interior, Washington 25, D. C. It should be accompanied by appropriate application form when a specific type of Government assistance is requested, in the form of (1) loan, (2) purchase contract, (3) Government guarantee of a private loan, (4) priorities or allocation of mining equipment, and maintenance, repair and operating supplies, and (5) other forms of Government assistance that might arise under the Act. Submit four (4) signed copies of the form and accompanying papers. Name and address should be stamped or typed on each sheet of this form and all accompanying papers. *When a question is inapplicable it should be so stated on the form.* Additional sheets may be attached in answering any questions or in supplying additional information. (IF YOU CANNOT ANSWER A QUESTION, SO STATE.) If a question is answered elsewhere indicate where answered. It is not necessary to answer it again.

GENERAL TECHNICAL DATA

Supply the following information on separate sheets, arranged, numbered, and lettered as indicated:

Materials produced:
- (*a*) What are the chief mine, mill, or smelter products?
- (*b*) What are the byproducts, if any?

Name(s) and type(s) of mine(s), mill(s), smelter(s), refinery(ies), pit(s), quarry (ies), drilling operation(s). Include old names of property, if any. Show extent of workings, including the following:
- (*a*) Linear feet of shafts.
- (*b*) Linear feet of drifts and crosscuts.
- (*c*) Linear feet of tunnels or adits.
- (*d*) Linear feet of other mine openings (explain briefly).

Indicate whether mine is flooded or not. Describe any pumping problems. Give size or productive capacity.

For each operation listed above supply the following:
- (*a*) Distance and direction from nearest town and shipping point.
- (*b*) Mining district.
- (*c*) Township, Section, Range.
- (*d*) County, State.

(*a*) State whether or not property is now in operation, and if in operation, by whom operated.

(*b*) Are you operating this property as:
- ☐ Owner.
- ■ Lessee.
- ☐ Contractor.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
MAY 5 1952

Number of years in production _____

If not in production or operation, estimated date when production will begin _____

Experience of operators:

Describe the mining and general business experience of (*a*) the applicant, and (*b*) the person or persons who manage the project.

History:
- (*a*) Give a statement, as complete as possible, of previous exploration, development, operation, and production of property, with reasons for suspension of operation.
- (*b*) State briefly the known history and production of adjoining and neighboring properties.
- (*c*) Furnish any available (private) reports that may apply to this application, including results of mine examinations, recommended exploration and development, and metallurgical investigations.

Names and addresses of Officers, Directors, or Partners, and in addition thereto, the five largest stockholders if applicant is a corporation.

Name and Address (a)	Official Title (If officer is also director indicate by "D") (b)	Total of Annual Salary, Commissions, Bonuses, Etc., Received From Applicant and Affiliates During Last Fiscal Year (c)	Estimated Net Worth Outside of Interest in Applicant (d)	Number of Shares Held in Applicant Corporation		Life Insurance Carried for Benefit of Applicant	
				Common (e)	Preferred (f)	Amount (g)	Net Cash Surrender Value After Loans (h)
	Total		x x x x x			x x x x x	x x x x x

If more lines are needed continue on separate sheet.

Capital Stock Issues:

For Corporate Applicants

Item	Authorized (a)	Outstanding (b)	Par Value (c)	Number of Shares Outstanding (d)	Dividend Rate Last Paid* (e)
ommon stock	$	$	$		
referred stock	$	$	$		

ndicate period covered.

). Production:

Item	Kind of Product (a)	1948 Total (b)	1949 Total (c)	1950 Total (d)	Present Average Monthly (e)
Quantity of product mined or quarried (Short, long, metric tons; barrels; pounds; etc.)					
Quantity of product processed (specify unit of measure and type of process)					
Quantity and grade of product sold or shipped (specify units of measure)					

. Do you contemplate a change in the present average monthly rate of production? If so, state estimated maximum monthly production and basis of change.

. Ore or Mineral Reserves:

(*a*) Describe the ore or mineral deposit briefly. Accompany the application by any available report on the geology and ore reserves.

(*b*) If deposit is other than placer:

(1) Submit assay plans and/or sections showing location and size of proved (measured) and probable (indicated) ore or mineral reserve.

(2) State the tonnage (indicate type of ton) and grade of each class of ore reserve, as above, and show how computed. Tabulated total ore reserve as follows:

TOTAL ORE OR MINERAL RESERVES

Ore or Mineral Reserve	Estimated Tons (a)	Metal or Mineral Content Per Ton (Grade) (b)	Gross Value Per Ton (c)	Recoverable Unit Value Per Ton (d)	Estimated Cost of Production Per Ton (e)
easured (proved)					
dicated (probable)					

(*c*) If placer:

(1) Give estimated total yardage and average marketable mineral content of each deposit.

(2) Submit map showing location of placer deposit and surrounding area, with all test holes or pits. Submit logs of each hole and test pit with depth and average value of each.

(3) Describe gravel, stating whether fine, medium or coarse; loose, tight, cemented, or frozen, and whether it contains stumps or boulders more than 1 foot in diameter; if so, how large, and in what proportion.

(4) Describe bedrock, giving type (granite, sandstone, shale, etc.) and state whether it is hard or soft, smooth, uneven or rough.

(5) Describe overburden, stating whether loose, tight, or cemented; fine or coarse textured; furnish estimate of average thickness and total amount.

(6) Tabulate the reserves using the form outlined above for ore or mineral reserves.

3. Access Roads:

Give road distances to shipping, supply and residence points, stating kind and condition of roads.

4. Water Supply:

State source and quantity of water available for operations and whether sufficient for all seasons of year.

5. Power:

State amount of power used, rate per hour, and source thereof.

6. Labor:

State number and classes (miners, muckers, millmen, etc.) of men employed during a recent representative payroll period.

7. Equipment and Facilities:

Describe present equipment on the property, including buildings. (State condition.) List major pieces of equipment now owned or controlled and in serviceable condition available for this operation.

8. Are there any particular conditions or circumstances affecting your operations that are not described above? If so, explain.

CERTIFICATION

The undersigned company, and the official executing this certification on its behalf, hereby certify that the information contained in this form and accompanying papers is correct and complete to the best of their knowledge and belief.

CORANDA CORPORATION
(Name of company)

By J. H. Rodda President
(Signature of authorized official)

April 29, 1952
(Date)

President
(Title)

Title 18, U. S. Code (Crimes), Section 1001, makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

U. S. GOVERNMENT PRINTING OFFICE 16—63792-1

GENERAL TECHNICAL DATA FOR
USE UNDER THE DEFENSE PRODUCTION
ACT OF 1950

For the -

HAWTHORNE ANDALUSITE - CORUNDUM DEPOSITS
THE HAWTHORNE MINING DISTRICT
MINERAL COUNTY, NEVADA

Question 1 (a) and 1 (b)

No mining operations are being carried on at the present time. Chief mill products will be Andalusite and Corundum. By-products will be scrap mica and quartz.

Question 2

Question not applicable as no mining operations are being carried on at this time. a, b, c, and d of question not applicable excepting on Green Talc property, on which two shallow test pits have been made. No flooding or pumping problems are anticipated in this area.

Question 3 (a)

Four groups of claims are located as follows:

(1) The Green Talc Group - 5 miles northeasterly of Thorne, Nevada.
(2) Bismark Group - 8 miles due East of Thorne, Nevada.
(3) Deep Mines Group - 7 miles southeasterly of Thorne, Nevada.
(4) Victory Group - 6 miles easterly of Thorne, Nevada.

A centrally located shipping point will be located near Dover siding on the Southern Pacific Railroad when production plans are made up.

Question 3 (b)

All four groups of claims are located in the Hawthorne Mining District.

Question 3 (c)

Green Talc Group of claims is located in Township 9 North Range 31 East in Sections 22, 23, 26 and 27.

Bismark Group is located in Township 9 North Range 32 East in Sections 31 and 32.

Deep Mines Group is located in Township 8 North Range 31 East, M.D.M., in Sections 13, 14, 23 and 24.

Victory Group is located in Township 9 North Range 31 East in Sections 25 and 26.

Question 3 (d)

Mineral County, Nevada

Question 4 (a)

None of the four groups of properties are in operation at the present time.

Question 4 (b)

Applicant listed is Lessee

Question 5

Question not applicable. Estimated date when production will begin will be November, 1952.

Question 6 (a)

Not applicable as applicant is a new corporation.

Question 6 (b)

F. L. DiNapoli - Age 49. President of Sun Garden Packing Company and director of several corporations. Engaged in fruit packing business since 1932. Married with three children. Extensive property interests and executive head of various business enterprises in Santa Clara County and elsewhere in California. Sun Garden Packing Company does $6,000,000.00 gross business per year and is a leading firm in its field. Mr. DiNapoli and family control 50% interest of Sun Garden Packing Company and also 50% interest in Mayfair Packing Company.

Question 6 (b) Cont'd

Joe P. Perrucci. - Age 46. President of Mayfair Packing Company. Engaged in many financial enterprises. Married with three children. Mayfair Packing Company is a leading firm in the dried fruit industry in California. Mr. Perrucci owns 50% interest in Mayfair Packing Company and also 50% interest in Sun Garden Packing Company.

James F. Boccardo - Age 40. Married with two children. Attorney-at-law since 1934. Experienced lawyer, director and officer of many corporations engaged in various business enterprises.

J. H. Rodda - Age 46. Married with one child. President of Victor Building Company, Vice President of Sunal Oil Company. University graduate in chemistry. Has had executive experience and directorship in several corporations engaged in various business enterprises.

R. B. Holt - Age 30. Married with three children. Graduate chemical engineer. Process development and chemical engineering experience with refractory materials. Has had executive and business experience in chemical manufacture. Also is now a trustee and former president of a non profit organization.

C. M. Peters - Graduate geologist, University of Washington. 18 years mining and geology experience. Licensed engineer in State of Washington. Member of the A.I.M.E.

L. B. Spencer - Licensed civil and mining engineer with many years experience in mining industry. Former experience with Andalusite - Corundum deposits controlled by Champion Sillimanite Corporation, a subsidiary of Champion Spark Plug Corporation.

Question 7 (a)

Little or no exploration, development, operation and production of properties have been practiced to date, excepting work performed by the Bureau of Mines in 1945, which is reported in War Minerals Report No. 388. This report is quite extensive and includes results of pilot plant concentration tests. A limited operation was practiced in 1949 by the Technical Porcelain Company of El Cerrito, California. Approximately 3,000 tons of ore were shipped. Generally speaking, operations were limited for lack of development and sufficient capital to carry on operations.

Question 7 (b)

Question 7 (b)

The only other known production came from the Dover property, which was performed by the Tillotson Refractories Company of Los Angeles, during which time approximately 3,000 tons were shipped.

Question 7 (c)

No private reports are available excepting War Minerals Report 388, a copy of which is attached.

Question 8

a	b	c	d	e	f	g	h
J. H. Rodda 1291 Emory San Jose, Cal.	Pres.	Not applicable as applicant is a new corp.	$150,000	16	none	none	none
R. B. Holt 158 Clough Ave. Irvington, Cal.	Sec-Treas.		$10,000	16	"	"	"
J. F. Boccardo 40 Wildway Los Gatos, Cal.	Dir.		$500,000	16	"	"	"
F. L. DiNapoli 699 E. SanCarlos San Jose, Calif.	Dir.		$750,000	16	"	"	"
J. P. Perrucci 535 Losse San Jose, Cal.	Dir.		$650,000	16	"	"	"
F. L. Fulkerson 1347 Christina San Jose, Calif.	Dir.		$15,000	16	"	"	"

Question 9

a	b	c	d	e
$1,000,000 None	$98.00 None	$1.00 None	98 None	none None

Question 10

Question not applicable as no mining operation has been practiced.

Question 11

Question not applicable.

Question 12

See War Minerals Report No. 388, page 4. Insufficient information to estimate total ore or mineral reserves.

Question 13

Road distances from mining locations to shipping points are as follows:

Green Talc to Thorne - approximately 5 miles.
Victory Group to Thorne - approximately 6 miles.
Bismark to Thorne - approximately 6 miles.
Deep Mines to Thorne - approximately 7 miles.

The city of Hawthorne is generally located and would serve as resident points. Road conditions to the four groups of claims are such that the general requirements would be met with bulldozer work.

Question 14

Water is generally available from wells which are supplied by percolation from Walker Lake and would be sufficient for all seasons of the year.

Question 15

Power requirements are not known at the present time and will not be available until completion of exploration and accumulation of pre-construction cost data.

Question 16

Question not applicable.

Question 17

Question not applicable as property is not in operation.

Question 18

Question not applicable.

Supplemental Information

PROPOSED DIAMOND DRILL HOLES

DEEP MINES GROUP

		Strike	Dip
Hole 1	- 500'	Approx. N40W	-45°
" 2	- 250'		Vertical
" 3	- 250'		Vertical
" 4	- 500'		Vertical
" 5	- 500'		Vertical
" 6	- 250'		Vertical
" 7	- 250'		Vertical
	2500'		

BISMARK GROUP

Hole 1	- 400'	Approx. N40W	-45°
" 2	- 300'		Vertical
" 3	- 300'		Vertical
" 4	- 400'	Approx. N45W	-45°
" 5	- 400'	Approx. N40W	-35°
" 6	- 400'		Vertical
" 7	- 300'		Vertical
" 8	- 300'		Vertical
" 9	- 350'		Vertical
" 10	- 250'		Vertical
	3400'		

ALTO AND GREEN TALC CLAIMS GROUP

Hole 1	- 600'	Approx. EW	-45°
" 2	- 600'	Approx. EW	-45°
" 3	- 500'	Approx. EW	-45°
" 4	- 400'	Approx. EW	-45°
" 5	- 400'	Approx. EW	-45°
" 6	- 600'	Approx. S78W	-45°
" 7	- 600'	Approx. S78W	-30°
" 8	- 500'	Approx. N-S	-45°
" 9	- 500'	Approx. N78W	-45°
" 10	- 250'		Vertical
" 11	- 400'	Approx. EW	-45°
" 12	- 250'		Vertical
" 13	- 250'		Vertical
" 14	- 250'		Vertical
" 15	- 250'		Vertical
" 16	- 250'		Vertical
" 17	- 250'		Vertical

Supplemental Information

ALTO AND GREEN TALC CLAIMS GROUP (Cont'd)

		Strike	Dip
Hole 18	- 350'		Vertical
" 19	- 400'	Approx. N30W	-60°
" 20	- 350'	Approx. N65W	-45°
" 21	- 450'	Approx. N45E	-45°
	8400'		

VICTORY GROUP

8 holes 350 ft.		Approx. NS	-45°

DIAMOND BITS, DRILLS
AND
DRILLING EQUIPMENT

Telephone SUTTER 1-6850

DIAMOND TOOLS FOR
INDUSTRIAL AND
SCIENTIFIC PURPOSES

Processed Diamond Bit & Tool Company
INCORPORATED
66 RITCH STREET
San Francisco 7, California

April 25, 1952

The Coranda Corporation
386 Race Street
San Jose, California

Attention: Mr. J. H. Rodda

Gentlemen:

We have inspected the property you contemplate drilling near Hawthorne, Nevada and we are willing to contract 20,000 feet of hole at the price of $6.50 per foot. This is to be AX Hole of 1 1/8" Core with the privelege of reducing to EX Hole of 7/8" Core in the event that we hit gravel seams on the longer holes.

This price is to include all labor, material, equipment, and the hauling of water from Hawthorn to drill site—also all diamonds, bits and reamers.

We estimate that we can do this work in approximately 90 days. This will necessitate using four to six diamond drills 2 shifts per day for 7 days per week. We have equipment available and can start the drilling as soon as you are ready.

Very truly yours,

PROCESSED DIAMOND BIT AND TOOL CO. INC.

Fred W. Rolland

Fred W. Rolland

FWR:bb

20M-3-51 FORM 407

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881

PITTSBURGH, PA.

AS A MUTUAL PROTECTION TO CLIENTS, THE PUBLIC AND OURSELVES, ALL REPORTS ARE SUBMITTED AS THE CONFIDENTIAL PROPERTY OF CLIENTS, AND AUTHORIZATION FOR PUBLICATION OF STATEMENTS, CONCLUSIONS OR EXTRACTS FROM OR REGARDING OUR REPORTS IS RESERVED PENDING OUR WRITTEN APPROVAL.

ORDER No. LABORATORY No.

651 Howard St. San Francisco

CLIENT'S No. FILE No.

REPORT

April 25, 1952

Coranda Corporation
386 Race Street
San Jose, California

QUOTATION

Attention: Mr. J. H. Rodda

We are submitting below prices on analysis of Andalusite to be submitted to us:

Class #1	Silica (SiO_2) Iron, Alumina and Titanium Oxides (R_2O_3 plus TiO_2)		$14.00
Class #2	Silica (SiO_2) Iron Oxide (Fe_2O_3) Alumina (Al_2O_3) Loss Ignition 1300°F Moisture		17.00
Class #3	Silica (SiO_2) Iron Oxide (Fe_2O_3) Alumina (Al_2O_3) Titanium (TiO_2) Manganese (Mn_3O_4) Calcium (CaO) Magnesium (MgO) Loss Ignition Sodium Na_2O Potassium K_2O	per sample	25.00
Petrographic Analysis		Max. each	50.00
Cone value		each	15.00

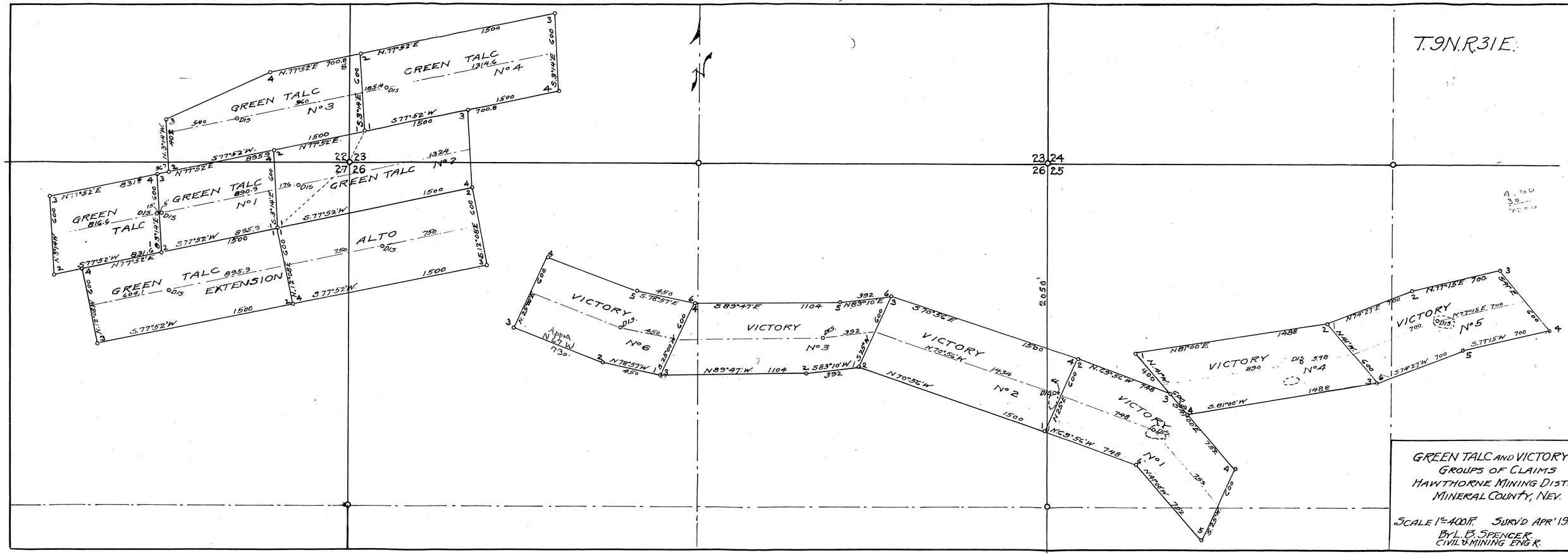
The above quotations are based on a minimum of five samples submitted at one time.

Respectfully submitted,

PITTSBURGH TESTING LABORATORY

W. W. Clark
Manager Laboratories

W. W. Clark
bk
cc: 8 - above


T.9N.R.31E.
GREEN TALC
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ALTO
VICTORY
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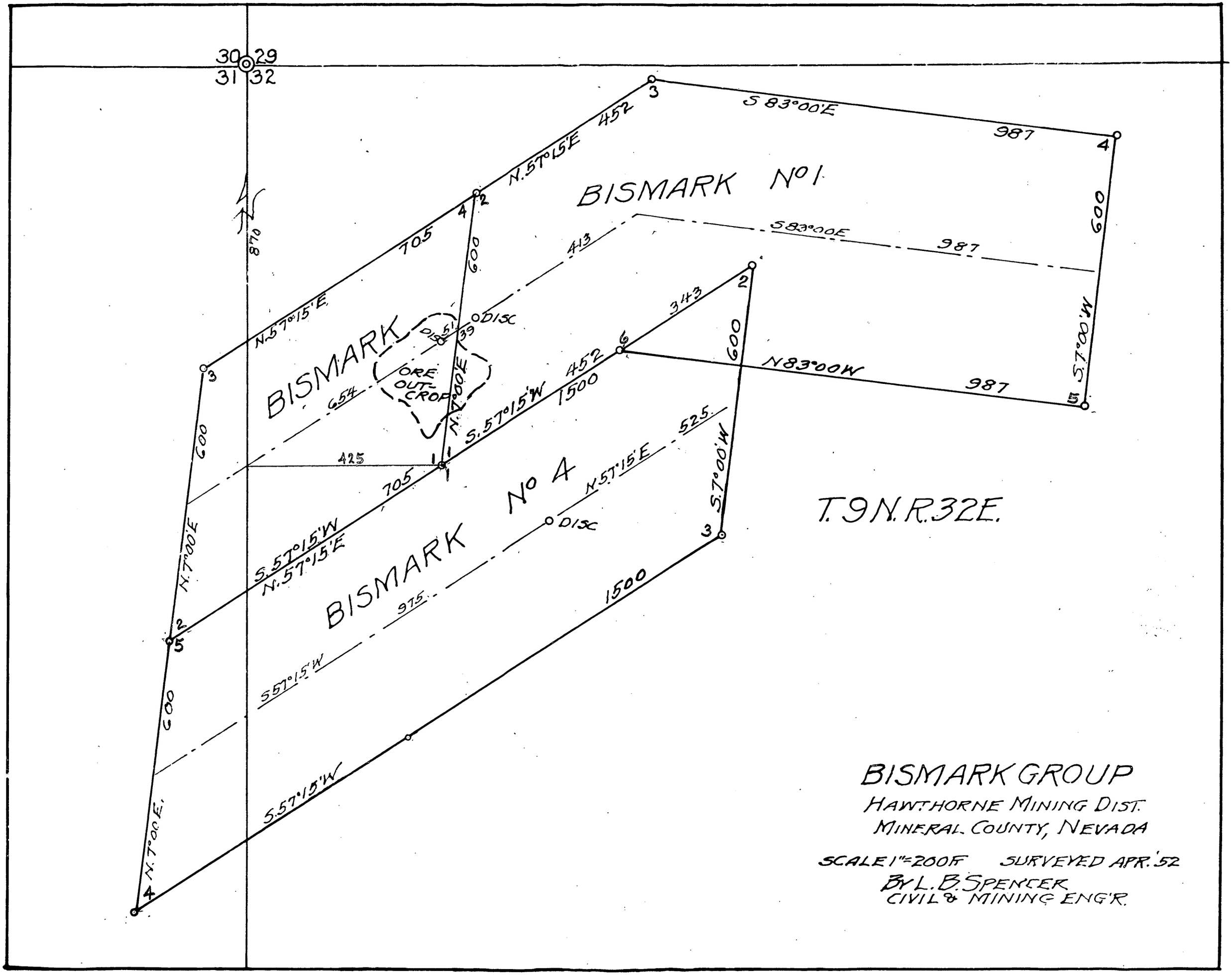
N°3
VICTORY
N°2
VICTORY
N°1
VICTORY
N°4
VICTORY
N°5
GREEN TALC AND VICTORY
GROUPS OF CLAIMS
HAWTHORNE MINING DIST.
MINERAL COUNTY, NEV.
SCALE 1" = 400 FT. SURV'D APR' 1952
BY L. B. SPENCER
CIVIL & MINING ENG'R.


30 29
31 32
BISMARK No 1
S 83°00'E
987
600
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705
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413
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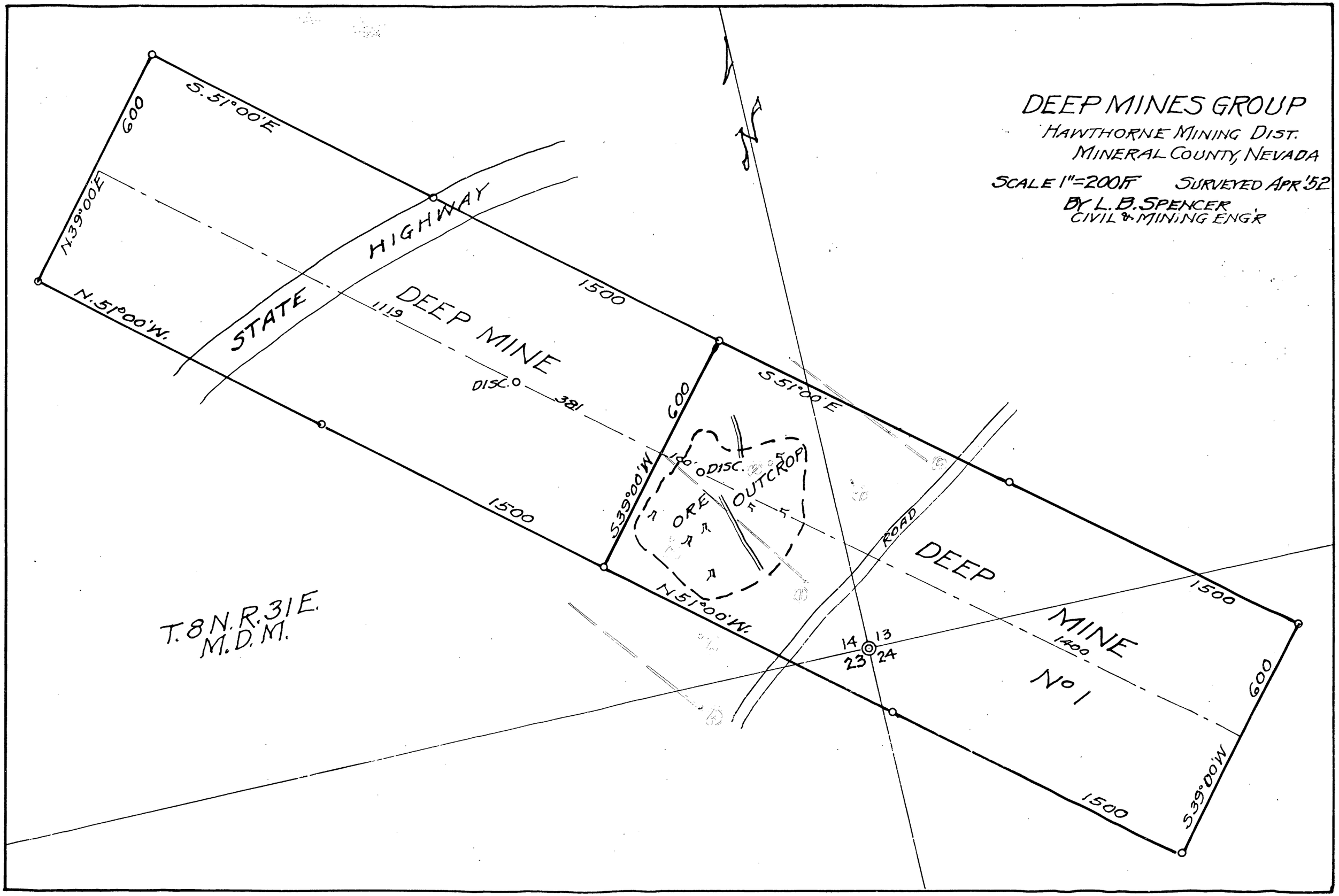
BISMARK
654
DISC
ORE OUT-CROP
N.7°00'E
S.57°15'W
452
1500
343
600
N83°00W
987
S.7°00'W
600
425
705
525
S.7°00'W
N.57°15'E
BISMARK No 4
DISC
S.57°15'W
N.57°15'E
N.7°00'E
975
1500
S.57°15'W
600
S.57°15'W
N.7°00'E
870
T.9N.R.32E.
BISMARK GROUP
HAWTHORNE MINING DIST.
MINERAL COUNTY, NEVADA
SCALE 1"=200FT SURVEYED APR.'52
BY L.B.SPENCER
CIVIL & MINING ENG'R.


DEEP MINES GROUP
HAWTHORNE MINING DIST.
MINERAL COUNTY, NEVADA
SCALE 1"=200ft SURVEYED APR '52
BY L. B. SPENCER
CIVIL & MINING ENG'R
N
S.51°00'E
600
N.39°00'E
N.51°00'W.
STATE
HIGHWAY
DEEP MINE
1119
1500
DISC.
381
600
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S.39°00'W
100
DISC.
ORE
OUTCROP
ROAD
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DEEP
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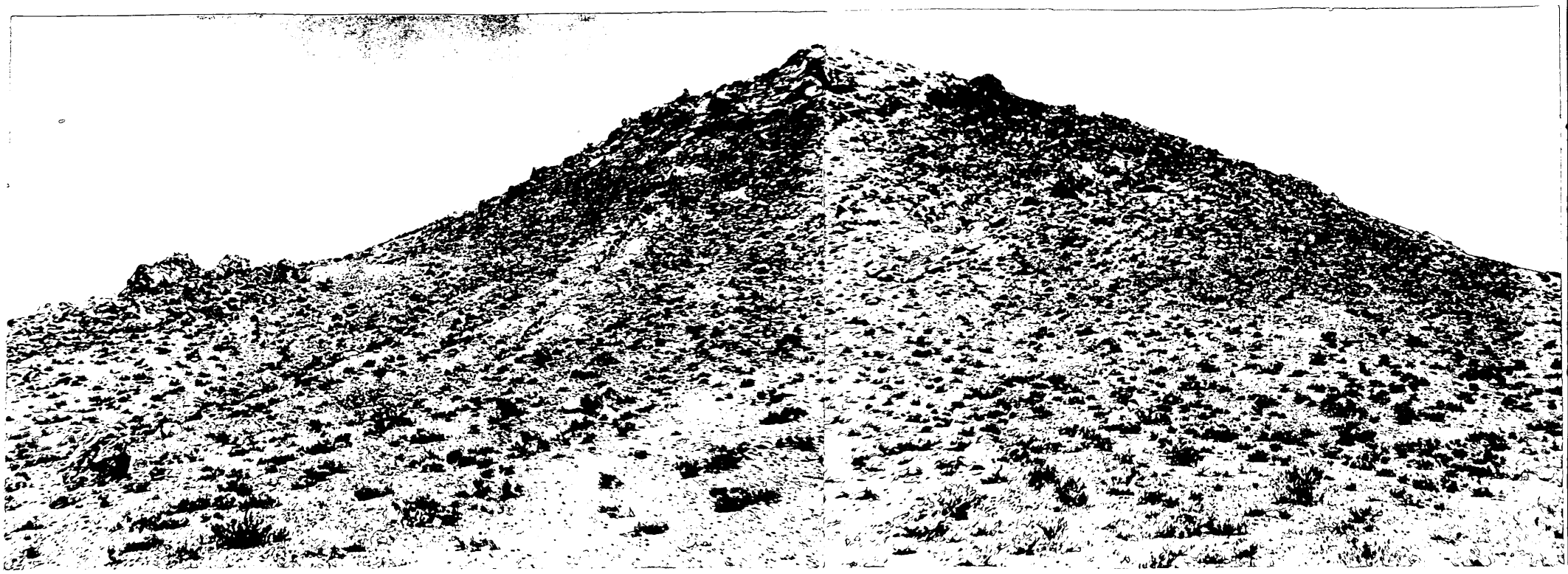
1400
No 1
1500
14
13
23
24
600
S.39°00'W
1500
T.8N.R.31E.
M.D.M.

1. Looking to North West on Bismark Claims. Outcrop in picture 2 shows at end of road to left of central hill. White spot on top of hill part of ore bearing structure strike extends left to right over hill.

2. Outcrop on Bismark Claim Group looking East along strike of structure.

3. Extension of geologic structure to West on the Bismark Claims.



4. Panorama of Deep Mine outcrops looking North. Starting at the left working, the upper limit of the ore zone extends through the lower third of the vertical trench and rises to the upper right working and curves upward to the dark patch of rocks near the top right of the hill. It is reported that the ore zone extends beyond the lower limits of the picture.

5. Crest of hill on Deep Mine Claims part of this outcrop contains ore.

6. Green Talc Claims looking North, open cut in Picture 7 to the right over buildings.

7. Open cut on Green Talc Claims showing typical ore contacts.

8. General view looking North on Victory Claims.

UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

BUREAU OF MINES
R. R. Sayers, Director

War Minerals Report 388

PRELIMINARY PILOT-PLANT CONCENTRATION OF ANDALUSITE-CORUNDUM ORE FROM THE VICINITY OF HAWTHORNE, NEV.

WASHINGTON: 1945

This report is [illegible] for limited distribution among officials of the United States Government [illegible] should not be made available to unauthorized persons.

The War Minerals Reports of the Bureau of Mines are issued by the United States Department of the Interior to give official expression to the conclusions reached on various investigations relating to domestic minerals. These reports are based upon the field work of the Bureau of Mines and upon data made available to the Department from other sources. The primary purpose of these reports is to provide essential information to the war agencies of the United States Government and to assist owners and operators of mining properties in the production of minerals vital to the prosecution of the war.

PRELIMINARY PILOT-PLANT CONCENTRATION OF ANDALUSITE-CORUNDUM ORE FROM THE VICINITY OF HAWTHORNE, NEV.[1]

SUMMARY

The far-western area of the United States has relatively few developed deposits of minerals containing enough alumina to be used for the manufacture of high-alumina furnace refractories. The andalusite ore in the Hawthorne deposit is not sufficiently uniform to meet market specifications for refractory purposes, but it is possible that the ore may be beneficiated so as to produce a satisfactory concentrate. Preliminary tests have indicated that gravity concentration would produce the highest-grade product and would represent the simplest method of treatment.

Pilot-plant tabling tests were made on about 50 tons of ore that analyzed 42.5 percent Al_2O_3 and 54.2 percent SiO_2. Three flow sheets were used, each varying slightly in grinding and sizing procedure; 15 different concentrates were produced, which varied in grade from 52.1 to 72.4 percent Al_2O_3 and 44.9 to 25.2 percent SiO_2, the composited average being 62.3 percent Al_2O_3 and 35.1 percent SiO_2; the over-all ratio of concentration was 4.2 to 1. One special corundum concentrate containing 91.5 percent Al_2O_3 was made in addition.

The final value of the concentrates to the refractory industry will be determined by further large-scale tests conducted cooperatively by Pacific-coast refractory producers who will mix the concentrate with clay in an attempt to produce a super-duty fire brick.

INTRODUCTION

Modern industry steadily is increasing its demands for furnace refractories that possess a combination of high mechanical strength, low porosity and shrinkage, and resistance to abrasion at high temperatures. In many instances these demands have been fulfilled best by high-alumina refractories composed predominantly of the artificial mineral compound mullite, $3Al_2O_3 \cdot 2SiO_2$. Mullite is a product formed by the interaction of

1 By C. T. Baroch, ass't. supervising engineer; H. D. Snedden and V. B. Homme, associate metallurgists; and E. T. Schrenk, assistant mineralogist, Bureau of Mines.

silica and alumina in correct proportions at relatively high firing temperatures or may be obtained as a transition product of the decomposition of minerals of the kyanite group (andalusite, kyanite, and sillimanite) at high temperatures.

High-alumina refractories are neutral, and they flux or form slags with difficulty; consequently, they are used widely in lead and glass furnaces, clinker-zone linings in Portland cement kilns, in boiler-furnace settings used for high-ash coals, and in blast-furnace regenerators. A list of pyrometric cone equivalent values and chemical analyses of various grades of typical high-alumina brick are given in table 1.[2]

TABLE 1. - Typical analyses of high-alumina refractories

High alumina, class	Analysis, percent			
	50	60	70	80
Al_2O_3	51.5	60.8	70.6	79.4
SiO_2	41.9	33.3	22.8	15.8
TiO_2	2.7	3.0	3.7	2.1
Fe_2O_3	1.8	1.7	1.8	1.7
CaO	.1	.2	.2	.2
MgO	.5	.3	.3	.3
Alkalies	1.2	1.1	1.0	1.0
P.C.E., cone number	34-35	36-37	38	39
Temperature equivalent, °C.	1,773	1,815	1,835	1,865

Specifications for marketable andalusite require a product containing 60 to 65 percent Al_2O_3; it is sold frequently on the basis of a specific gravity ranging between 3.05 and 3.15. The Hawthorne deposits are not directly marketable as an andalusite of refractory grade, because most of the ore contains only 40 to 50 percent Al_2O_3.

Preliminary concentration tests made at the ore-testing laboratories of the Bureau of Mines, Salt Lake City, Utah, early in 1943 included gravity separation by "sink-float;" jigging and tabling methods on minus 1/2-inch, 3-mesh, and 35-mesh ore; electrostatic and electromagnetic separation on gravity separation products; and flotation with fatty acids, cationic reagents, and alcohols at high, intermediate, and low pH values.

Conclusions reached by the laboratory work showed that Hawthorne andalusite ore could be beneficiated as follows:

1. By table concentration of ore ground to minus 48-mesh and sized; 66.0 percent of the alumina was recovered in a product containing 63.2 percent Al_2O_3 and 35.8 percent SiO_2.

2. By cationic flotation of silica from ore ground to minus 100-mesh; 71.3 percent of the alumina was recovered in a product containing 60.0 percent Al_2O_3 and 39.4 percent SiO_2.

3. By fatty-acid flotation of ore ground to minus 100-mesh; 54.7 percent of the alumina was recovered in a product containing 60.7 percent Al_2O_3 and 37.8 percent SiO_2.

2 Rochow, W. R., Properties and Applications of Modern Refractories: Chem. and Met. Eng., vol. 42, 1935, p. 76.

Gravity concentration gave the highest-grade product and represents the simplest method of treatment; therefore, it appears to be the preferable method.

The value of clays and other minerals for refractory purposes can not be determined solely by chemical analyses, as many physical attributes of the materials and variations of processing techniques enter into the quality of a refractory. Consequently, it became apparent early in the investigation that the ultimate use-value of Hawthorne concentrates could be determined only by trial firings. This meant that a sizable quantity of concentrates would be required; therefore, 59 tons of the ore was shipped to the Boulder City, Nev., pilot plant. This ore was treated by table concentration, and concentrates were made in small lots of different grades and particle sizes for subsequent use in refractory firing tests. The refractory test work probably will be performed partly under cooperative agreements with Pacific-coast refractory manufacturers and partly by Bureau of Mines specialists in nonmetallic minerals.

DESCRIPTION OF THE ORE

The ore deposits are in the southern foothills of the Gillis Range about 10 miles northeast of Hawthorne, Mineral County, Nev. The Federal Geological Survey reports five groups of claims in the district. They are the Green Talc, Dover, Bismarck, Victory, and Deep Mines. The Bureau of Mines has made ore-dressing tests on samples from two of the groups - the Green Talc, controlled by William Rae and John Buich, and the Dover, controlled by B. H. Donnelly and associates. The original (Eriksen) sample tested by the Bureau of Mines is reported by Donnelly to be from his property. The sample treated in the Boulder City pilot mill was taken from the Green Talc group of claims.

Reserves

Little developing has been done, and no mineral reserve has been technically blocked in any of the deposits. Tonnage estimates of inferred mineral are based upon surface outcrops assumed to extend to a depth of 100 feet.

Green Talc group. - The main outcrop is approximately 800 by 200 feet in surface area. If assumed to extend to 100 feet in depth and to be of milling grade, 1,300,000 tons of inferred material is indicated.

Dover group. - No tonnage estimates can be made of mineral in this group because of surface overburden and insufficient development.

Deep Mines group. - Andalusite and associated aluminum silicate minerals outcrop over an area 300 by 300 feet. If mineralization is assumed to extend for a depth of 100 feet, 750,000 tons of milling-grade material may exist.

Victory group. - No mineral other than float has been found on this group. It was located recently and no work has yet been done.

Bismarck group. - Aluminum silicate minerals outcrop over an area 50 by 150 feet. If this deposit is assumed to extend to a depth of 100 feet, 62,500 tons of milling-grade minerals might be produced.

Estimated inferred mineral

	Tons
Green Talc group	1,300,000
Deep Mines group	750,000
Bismarck group	62,500
	2,112,500
Less 40 percent estimated for inclusions of dikes, quartzite, and submarginal material	845,000
Net	1,267,500

Submarginal mineral is that having a specific gravity less than 2.9.

The 59 tons of ore received for the test arrived in two truck-and-trailer shipments. The ore of the first truckload was characterized by large, conspicuous masses and veins of green sericite; the ore in the second shipment carried green sericite in small veins only. In general, the material is fine-grained, dense, and quite hard; it is gray to grayish-blue in color except in the zones or veins, in which the pale-green sericite predominates.

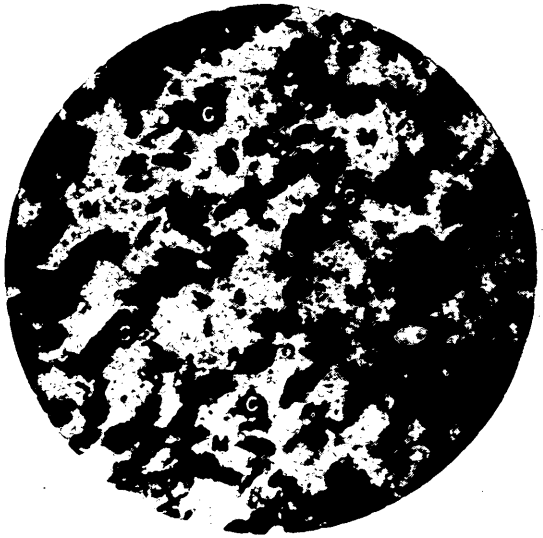
The rock appears to have been formed by contact metamorphism brought about by an igneous intrusion into argillaceous country rock and subsequently altered by hydrothermal action.

The principal minerals identified in thin sections include:

1. Andalusite. - Al_2SiO_5; specific gravity 3.16; hardness 7.5; usually breaks into prisms showing cleavage in one or two directions and an uneven fracture; changes to mullite at about 1,350° C. The andalusite in this ore is pale cream to milky white in color. It occurs chiefly as small crystals and remnants of crystals disseminated throughout the rock or occasionally as coarse crystals concentrated in short, thick, lenslike masses. In addition, all of the pale-green sericite veinlets examined contain small crystals of andalusite, typically shown in figure 1. Inclusions of sericite are common within individual andalusite crystals, and it appears that much of the original andalusite has been altered to sericite.

2. Corundum. - Al_2O_3; specific gravity 3.95-4.10; hardness 9; usually breaks into grains having irregular cleavage and uneven to conchoidal fracture; melting point, 2,050° C. Most of the corundum in this ore is deep blue in color, but some varies to almost white. It is disseminated throughout the ore, but areas of concentrated granular corundum are not uncommon. The crystals are very small, show inclusions of mica or mica-like minerals, and occur singly or in small clusters typically as shown in figure 2.

1



2

A - andalusite
C - corundum
Q - quartz
M - mica

Scale

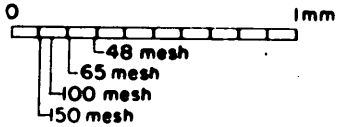


FIGURE 1.- Green sericite veinlet adjacent to andalusite crystals. Polarized light.
FIGURE 2.- Average gray-blue mottled ore. Corundum crystals in a groundmass of sericite. Plane light.

3. Mica. - Variable in composition but essentially acid salts of orthosilicic acid or acid aluminosilicate; specific gravity 2.7; hardness 2-2.25. Muscovite (potassium micas), sericite (fine-grained muscovite), and perhaps some paragonite (sodium mica) are present in the Hawthorne ore. Small books of muscovite were noted, but these are not abundant. However, sericite is abundant and occurs intimately mixed with the andalusite and corundum or independently in pale-green veinlets. Chemical analyses of selected material indicate that if the soda mica, paragonite, $H_2NaAl_3(SiO_4)_3$, is present, it is minor as compared to sericite, and that the sericite is low in potash, as shown in table 2.

TABLE 2. - Chemical analysis of pale-green sericite

	Percent		Percent
Al_2O_3	38.40	MgO	0.65
SiO_2	47.19	CaO	.28
Fe_2O_3	.32	TiO_2	.10
K_2O	8.18	B.	.08
Na_2O	.76	L.O.I.	4.32

4. Quartz. - SiO_2; specific gravity, 2.5; hardness, 7. Quartz is present throughout all of this material as very small anhedral crystals or else as small, rounded grains up to 0.2 mm. in diameter. It is most abundant as small anhedral grains associated with the sericite.

5. Pyrophyllite. - $H_2Al_2(SiO_3)_4$; specific gravity, 2.8-9; hardness, 1-2. One mica-like constituent of the ore was identified by X-ray and chemical analyses as pyrophyllite. The chemical and physical similarities of this mineral and mica prevent quantitative determination of either when both are present in an ore.

Several accessory minerals, including titanite, magnetite, and hematite, were noted in the thin sections, but their percentage is small. A chemical analysis of the ore is given in table 3.

TABLE 3. - Chemical analysis of ore

	Percent		Percent
Al_2O_3	42.50	Fe_2O_3	0.42
SiO_2	54.20	TiO_2	.77
K_2O	.73	Fe_m*	.12
Na_2O	.29	L.O.I., 800° C.	2.13

*Metallic iron from grinding.

Mineralogical analyses were made by using two different techniques on representative portions of the ore, the first at the Boulder City station and the second at the Salt Lake station.

The first mineralogical analysis was made by using a combination of heavy-liquid separation and interpretation of chemical analysis. To assure accuracy, several tests were made and each product was examined under

the petrographic microscope. Assuming that quartz, combined silica (mica), corundum, and andalusite are the variables in this ore, the percentage of minerals can be calculated from the chemical analysis if the percentage of corundum is known. Corundum was determined by separation with the heavy liquid methylene iodide, specific gravity 3.325, using a sample ground to pass a 150-mesh screen. The quantity of mica was calculated from the K_2O and Na_2O determined by chemical analysis, but insufficient alkali was present to account for the percentage of micas actually observed with the microscope. It is possible that pyrophyllite, $Al_2O_3 \cdot 4SiO_2 \cdot H_2O$, may be present and that it has been mistaken for sericite, because the optical properties of these two minerals are very similar.[3] If pyrophyllite is present in large amounts correct interpretation of chemical analyses is impossible, because andalusite and pyrophyllite are so closely related chemically and because heavy-liquid separation of pyrophyllite from sericite is not practical. Furthermore, if pyrophyllite is present, the percentage of andalusite and quartz must be reduced. The results of this analysis is given in table 4, column I.

The second mineralogical analysis was made by microscopic grain count on closely sized and carefully split fractions of the ore, using oils of varying refractive indices to distinguish the various minerals. Corundum was the only mineral identified above the index of refraction of 1.7400. The micaceous minerals and quartz were all found to be below the index of refraction of 1.6031, and all the material above this index was considered to be either andalusite or corundum. A microscopic count was then made on the same fractions, using an oil with an index of refraction of 1.7400, and all the material having a higher index was assumed to be corundum. The sample, ground to minus 100-mesh, was sized into eight products by screening and elutriation, and each fraction was weighed. A statistical count of each mineral type was taken on 500 grains in each fraction. The weighted average of the microscopic counts, which represents the volume of the different minerals, was transposed to weight percentage by assuming the gangue to have a specific gravity of 2.8, the andalusite 3.1, and the corundum 3.8. The results are given in table 4, column II.

TABLE 4. - Estimated mineral analysis of heads, specific gravity 2.95

	Weight, percent	
	I	II
Andalusite	30-35	20
Corundum	15-20	20
Mica	20-30	-
Quartz	20-30	-
Titanite	1-2	-
Miscellaneous	5-10	-
Gangue	-	60

3 Rogers and Kerr, Optical Mineralogy, 2d ed.: McGraw-Hill Book Co., Inc., New York, 1942, p. 351.

The two methods of mineralogical analyses check well regarding the amount of corundum present, but the values for andalusite are controversial. The difference in the latter could be accounted for by the presence of pyrophyllite, which has been reported by others as being present in some samples from the Hawthorne deposits. If it was present in the test sample under consideration, it was evidently too fine-grained to be positively identified with the microscope. Other factors affecting the accuracy of any mineralogical analysis include (1) difficulty of identifying submicroscopic particles produced by grinding to obtain liberation, (2) difficulty of identifying various intermediate decomposition products that occur in the ore, (3) difficulty of obtaining a small sample for microscopic analysis that is wholly representative of the ore.

TEST PROCEDURE AND RESULTS

The original laboratory tests indicated that the valuable minerals were free only at sizes finer than 35-mesh; even finer grinding appears to be necessary to free completely the mineral particles in the ore received for the pilot-plant work. The mineral-dressing tests also showed that the determination of the point at which to make cuts on the table between concentrate, middling, and tailing is difficult because there is little difference in the appearance of these products. Some preliminary tests were made on a small laboratory table using ultraviolet light, with and without filters, and various colored and fluorescent lights, but of these, only white fluorescent light intensified the bluish color of the corundum slightly. A pale wine-colored andalusite, sized to the table feed, was added to the feed in one test to determine whether or not this would act as a guide to give a suitable indication where a separating cut might be made; the method is satisfactory, but a large amount of the colored mineral is required.

The ultimate control method adopted consisted of specific-gravity determinations and frequent vanner plaque tests on samples of the table products. The bluish corundum could be distinguished readily on the vanner; its presence could be determined in the tailings and middlings, and the operators soon learned how to appraise the approximate grade of concentrate by the relative amount of the contained blue mineral.

The difference in specific gravity between andalusite, 3.16, and the quartz-mica gangue, 2.6-2.7, is not large, and their gravity separation by tabling requires careful adjustment of feed rate and close sizing of table feed. In the pilot-plant runs, ground ore was hydraulically classified or screen sized, the coarsest fraction tabled directly, and the finer sizes stored in tanks and tabled later. The same table was used for all the classified products. Three flow sheets were used, each varying in the method of preparing and sizing table feed.

First Flow Sheet

The first pilot-mill work was conducted according to the flow sheet shown in figure 3, and a screen analysis of the ball-mill feed is given in table 5.

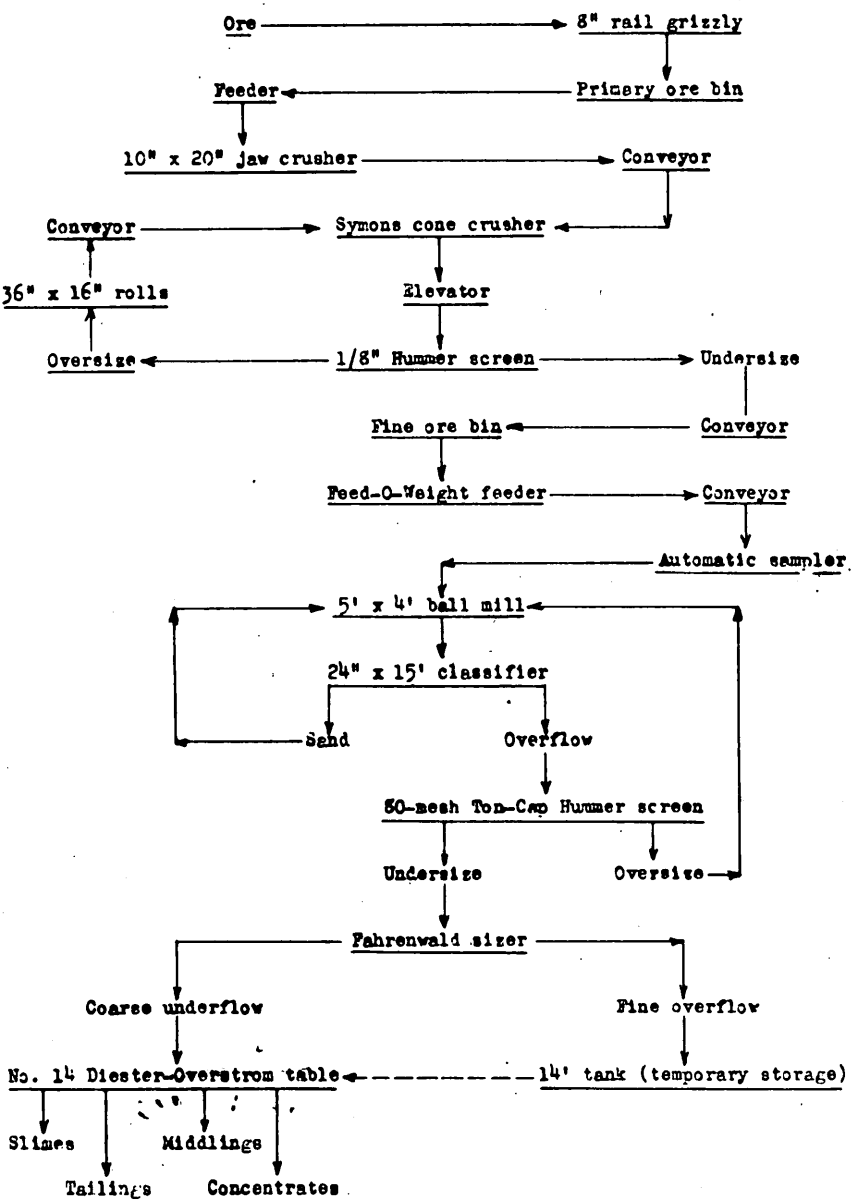


Figure 3. - First flow sheet.

TABLE 5. - Screen analyses of 1/8-inch ball mill feed

Mesh	Weight, percent	Cumulative, percent
-6+8.	15.67	15.67
-8+10	15.54	31.21
-10+14.	16.19	47.40
-14+20.	9.69	57.09
-20+28.	7.08	64.17
-28+35.	5.40	69.57
-35+48.	4.61	74.18
-48+65.	3.32	77.50
-65+100	3.71	81.21
-100+200. . . .	5.46	88.67
-200.	13.33	100.00

Fine ore was fed by means of a Merrick Feed-O-Weight constant-weight feeder, which recorded the weight of the ore. An automatic sampler cut the full stream of ore every 3 minutes. The ball mill, 5 feet in diameter by 4 feet long, was charged with 2,100 pounds of 4-inch balls, 2,250 pounds of 3-inch balls, and 650 pounds of 2-inch balls. The mill operated in closed circuit with a Dorr rake-type classifier 24 inches wide by 15 feet long, the overflow of which was pumped to a Hummer vibrating screen fitted with 80-mesh Ton-Cap sieve wire. Ball-mill feed rate was increased gradually to as high as 2,760 pounds per hour, but this is not the maximum capacity of the mill for this size feed, as very little sand was returned to the mill by the classifier. Pulp discharge from the ball mill contained 50 to 60 percent solids, and the classifier operated at 35 to 40 percent solids.

The original intention was to feed the 80-mesh screen oversize to the table, but flow of this product was too irregular for successful table operation, so the oversize was returned to the ball mill. Screen undersize contained a fair amount of material that was plus 80-mesh and all minus 48-mesh, as measured by standard Tyler sieves. This undersize was pumped to a 6-compartment type C Fahrenwald sizer used as a deslimer rather than as a sizer; overflow from the sizer was stored temporarily in a 14-foot tank, which, in turn, overflowed to a slime thickener and storage tank. The coarse fraction was treated while operating the grinding unit.

Only the cone of the Fahrenwald sizer was used to feed the table. A small amount of hydraulic water added to the cone when operating the grinding circuit removed most of the slime and fines, allowing the coarser particles to be fed to the table with the finer fraction. While tabling the stored overflow material, all of the hydraulic water was turned off, and the sizer was used only as a feeder for the table.

All of the material was tabled on a No. 14 Diester-Overstrom diagonal deck table 4 feet 8-3/4 inches wide at the head-motion end by 8 feet 3-3/4 inches long parallel to the head-motion axis; this table has less than half the area of a standard table with dimensions 6 feet 8-1/2 inches by 14 feet 3 inches. The table was pool-riffled for fine sands or slime separation, the ordinary riffles being 1/8-inch high at the head end by 1/4-inch

wide, every eighth riffle was a pool riffle 1/4-inch high. The table speed was 272 strokes per minute, and the length of stroke ranged from 3/8 to 3/4 inch, the shorter stroke being used on the finer feed. Vanning-plaque tests made in connection with tabling operations, particularly on the finer sizes, indicated that whenever the table was overloaded, fine corundum washed into the slimes and tailings.

A large, white, fluorescent light mounted over the table helped to determine the line of separation between the corundum and middling product, but andalusite was mostly obscured in the middling, and the depth of cut had to be determined by specific-gravity tests. These tests can be made quickly and accurately with the LeChatelier specific-gravity bottle.

To remove grinding iron from the concentrates, a narrow high cut was made on the table. This was treated later with an electromagnet to remove the iron. The remaining fraction, with an average specific gravity of 3.7, analyzed 91.5 percent Al_2O_3 and appeared to be principally corundum.

Six and one-half tons of ore was ground and classified in accordance with the first flow sheet, but the entire circuit was not cleaned out at the end of the run, and some of the finer material and the middling were left over, to be included in subsequent work. This portion of the work was a transitional stage devoted mainly to adapting the results of laboratory test work to large-scale equipment. The grinding procedure of the circuit produced excessive fines, showing that the Hawthorne ore is readily subject to overgrinding; this condition was the paramount reason for the change to the second flow sheet.

Chemical analyses and specific gravities of table products made while producing the second concentrate lot (first flow sheet) are shown in table 6.

TABLE 6. - Chemical analyses and specific gravities of table products, first flow sheet

Material	Specific gravity	Analysis, percent			
		Al_2O_3	SiO_2	Fe_2O_3	TiO_2
Concentrate.	3.28	67.8	28.77	0.85	0.71
Middling	2.97	44.8	49.00	.43	.92
Tailing.	2.85	33.0	57.24	.57	.87
Slime.	2.74	33.1	57.36	2.56	.77

Second Flow Sheet

The second flow sheet was similar to the first, except that a screen with a 1/2-inch opening replaced the 1/8-inch screen in the coarse-crushing section; the rolls were omitted, only the Symons cone crusher being used for secondary crushing, and a 48-mesh Ton-Cap screen replaced the 80-mesh screen used for sizing the ball mill classifier overflow. The screen analysis of table 7 was made on a representative sample of this coarser ore.

TABLE 7. - Analysis of ore crushed through a one-half inch screen

Mesh	Weight, percent	Cumulative, percent
-3/4"+1/2. . . .	4.27	4.27
-1/2"+4.	58.30	62.57
-4+6	7.90	70.47
-6+8	5.70	76.17
-8+10.	4.96	81.13
-10+14	3.23	84.36
-14+20	2.89	87.25
-20+28	2.25	89.50
-28+35	1.90	91.40
-35+48	1.48	92.88
-48+65	1.38	94.26
-65+100.	1.28	95.54
-100+200	1.87	97.51
-200	2.49	100.00

Ball mill feed rate on this coarser material was started at a rate of 2,760 pounds per hour and was increased to the maximum continuous capacity of 3,630 pounds per hour while grinding through the 48-mesh Ton-Cap screen. The ball mill discharge pulp was maintained between 50 and 60 percent solids, which was diluted to give a classifier overflow product of between 40 and 45 percent solids. A screen analysis made on a sample of the 48-mesh Ton-Cap screen undersize is shown in table 8.

The coarser crushing and grinding still tended to create an excessive quantity of fines and slimes. For classifying, the cone of the Fahrenwald sizer was eliminated, and the third compartment was used to feed the table. A sample of the coarse table feed from the sizer, taken at the same time as the preceding screen undersize sample, yielded the screen analysis also shown in table 8. A screen analysis of the sizer overflow is given in the last column of table 8.

TABLE 8. - Screen analysis of 48-mesh screen undersize product and Fahrenwald sizer products

Mesh	Weight, percent		
	Screen undersize	Sizer underflow	Sizer overflow
-20+35. . .	0.61	3.41	-
-35+48. . .	7.40	24.06	-
-48+65. . .	7.56	35.74	0.52
-65+100 . .	13.13	23.51	3.57
-100+200. .	21.07	12.34	42.72
-200. . . .	50.23	.94	53.19

Table capacity of the coarser material was 350 to 450 pounds per hour. The small difference in specific gravity of the minerals prevented them from spreading out over the table, causing the entire table feed to follow along the ends of the riffles and to fan out to about 18 inches at the concentrate end. A narrow band of bluish-gray corundum was visible along the upper edge of the fan. The fine table feed formed a much wider corundum band, which was attributed to better liberation and a smaller amount of middling product. The spread of the fan in this case, virtually covered

the entire concentrate end of the table, reducing the table capacity to 200 or 250 pounds of dry feed per hour. Tilting the table more would wash the concentrates over the tailing side. Most of the slime and coarse mica washed off the head end of the table, regardless of the feed size.

Approximately 33 tons of minus 1/2-inch ore was milled in accordance with flow sheet 2, producing concentrates 3 to 9, inclusive. Inasmuch as 50 percent of the ore was ground to minus 200-mesh in this circuit, it was decided to attempt a lighter grind and a coarser table feed with additional classification before tabling.

Third Flow Sheet

The third flow sheet is outlined in figure 4. The 2,100 pounds of 4-inch balls in the mill were removed and replaced with an equal weight of 1-1/2-inch balls in an effort to reduce over-grinding. The 48-mesh screen receiving the ball mill classifier overflow product was replaced by a 20-mesh screen, and the undersize from this passed to another rake classifier 24 inches wide by 15 feet long. Classifier sand product passed to the Fahrenwald sizer, where two pockets were used to produce two underflow sized products instead of one as in the previous flow sheets. The coarsest sizer product flowed directly to the table, the intermediate product was stored temporarily in a 7-foot tank, and the sizer overflow was combined with the classifier overflow to be stored in the 14-foot tank.

The change in the ball load did not noticeably affect operation of the ball mill; the maximum feed rate remained at 3,630 pounds per hour. Screen analyses of the classifier sand discharge and the three table feed products are shown in table 9.

TABLE 9. - Screen analyses of classifier and Fahrenwald sizer table feed products, flow sheet 3

Mesh	Weight, percent			
	Classifier 2 sand discharge	Fahrenwald sizer products		Classifier and Fahrenwald overflow products
		Coarse	Intermediate	
-20+28 .	6.67	16.74	-	-
-28+35 .	8.05	17.61	1.60	-
-35+48 .	12.76	22.61	6.91	-
-48+65 .	16.88	17.39	14.63	-
-65+100.	21.10	11.96	29.26	-
-100+200	21.49	10.87	43.09	16.87
-200 . .	13.05	2.82	4.51	83.13

Approximately 8 tons of ore was treated by the process shown in the third flow sheet and produced concentrates 10 and 11, the former from the coarse and intermediate sizer products and the latter from the classifier and sizer overflows. The middling from this run was stored separately from the middling products made previously and was tabled again later to produce concentrate 14.

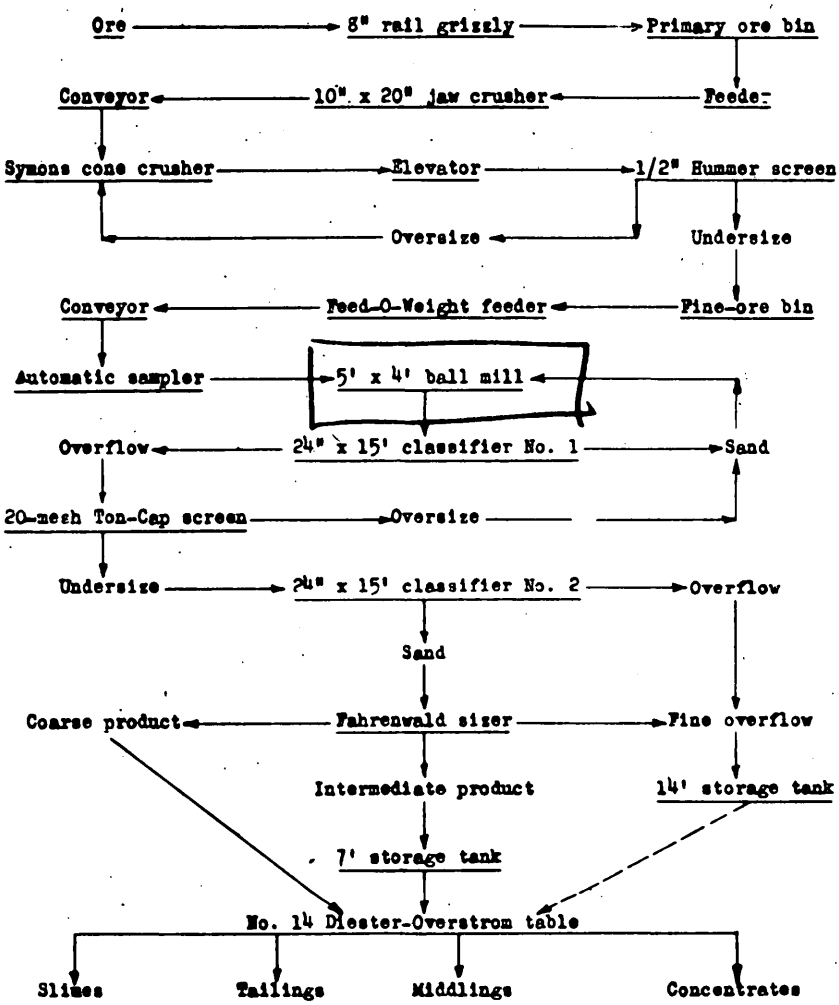


Figure 4. - Third flow sheet

Re-treatment of Middlings

A total of 8.94 tons of various middlings, dry weight, was produced from the 47.5 tons of ore used in the three flow-sheet processes. The middlings contained some free corundum and a fair amount of andalusite, which were recoverable by tabling without regrinding. Partial analyses of the middlings products are given in table 10.

The middlings from the first and second flow-sheet processes were passed over a 100-mesh Hummer screen and separated into a coarse and fine product, each of which was tabled separately to make concentrates 12 and 13, respectively. Middling from the third flow-sheet process was treated separately to produce concentrate 14. The rejected portion of the

middling has been called coarse and fine middling tailing in the summarized data.

TABLE 10. - Analyses of middlings

Number	Percent			
	Al_2O_3	SiO_2	Fe_2O_3	TiO_2
1	44.6	46.5	0.99	0.82
2	44.8	49.0	.43	.92
3	41.3	51.2	.49	.61
4	48.9	45.9	.28	.66
5	51.4	42.1	.28	.77
6	47.7	42.6	.35	.92
7	45.2	46.8	.31	1.17
8	47.9	46.3	.35	.92
9	44.4	49.4	.42	.82
Weighted average	45.3	47.4		

Concentrates and Recovery Data

Weights, particle size, specific gravity, and chemical analyses of all the concentrates are listed in table 11, and the pyrometric cone equivalents for each concentrate are listed in table 12.

The concentrates show a wide range in grade which, excluding the small amount of high-grade corundum recovered as concentrate 16, varied between 52.1 to 72.4 percent Al_2O_3 and 25.2 to 44.9 percent SiO_2. This range of concentrate grade may prove to be valuable, as the main objective of this work was to produce enough high-alumina material so that refractory tests could be made to determine the value of the products.

TABLE 12. - Pyrometric cone equivalents,* andalusite-corundum concentrates

Concentrate	Assay, percent		P. C. E.* No.	Temperature, °C.
	Al_2O_3	SiO_2		
1	62.6	34.5	37+	1,820+
2	60.4	37.6	37+	1,820+
3	60.3	35.9	38-	1,835-
4	67.6	29.3	38	1,835
5	69.2	28.7	39	1,865
6	67.1	28.7	40	1,885
7	66.3	29.5	38+	1,835+
8	72.4	25.2	38	1,835
9	68.0	30.2	40+	1,885+
10	65.4	33.6	38	1,835
11	65.8	32.3	39+	1,865+
12	52.1	44.9	35+	1,785+
13	62.2	35.7	38+	1,835+
14	52.3	44.1	35-	1,835-
15	59.0	39.6	37.5	1,827
16	91.5	5.7	41-	1,970-
Composite	62.3	35.1	38	1,835

*As determined by Northwest Experiment Station, Bureau of Mines, Seattle, Wash.

A large proportion of each concentrate has been shipped to Gladding, McBean & Co. at Pittsburg, Calif., for testing their value as a refractory. Other proportionate parts of the concentrates have been distributed within the Bureau of Mines for refractory and other test work.

TABLE 11. - Andalusite-corundum concentrates

Flow sheet	Concentrate	Weight pounds	Particle size*	Specific gravity	Chemical analyses, percent						
					Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O	MnO_2**
1	1	440	Fine	3.37	62.6	34.5	0.89	0.71	0.27	0.11	0.75
1	2	640	do.	3.28	60.4	37.6	.98	.71	.29	.03	.13
1-2	3	1,587	Coarse	3.20	60.3	35.9	.63	.87	.36	.05	.10
2	4	588	Fine	3.31	67.6	29.3	.42	.77	.25	.02	.05
2	5	550	do.	3.36	69.2	28.7	.56	.87	.34	.02	.05
2	6	555	do.	3.36	67.1	28.7	.56	.77	.31	.07	.09
2	7	1,873	Coarse	3.33	66.3	29.5	.49	.77	.34	.07	.03
2	8	1,171	do.	3.40	72.4	25.2	.78	.82	.25	.06	.04
2	9	3,323	Fine	3.33	68.0	30.2	.42	.77	.17	.07	.10
3	10	752	Coarse	3.27	65.4	33.6	.54	.87	.35	.13	-
3	11	1,923	Fine	3.28	65.8	32.3	.58	.66	.29	.17	.10
Middling.	12	5,214	Coarse	3.08	52.1	44.9	.49	.77	.48	.25	.05
Do.	13	3,030	Fine	3.24	62.2	35.7	.42	.66	.26	.17	.12
Do.	14	221	Coarse	3.10	52.3	44.1	1.09	.77	.53	.19	.08
Clean-up.	15	556	Fine	3.22	59.0	39.6	.41	.77	.38	.07	.70
Hi-grade.	16	182	do.	3.76	91.5	5.7	.70	.77	.08	Tr.	.40
Composite		22,605		3.25	62.3	35.1	.53	.76	.32	0.15	-

*The fine size is approximately minus 65-mesh. The coarse size is approximately minus 20-mesh with some minus 100-mesh.

**MnO_2 is an extraneous impurity resulting from contact of the ore with launders, pipe lines, and other equipment that had previously been used for manganese milling tests.

Andalusite is marketed on a specification of 60 to 65 percent Al_2O_3 content and a specific gravity of 3.05 to 3.15. Many buyers also specify that 25 to 50 percent of the product should be minus 4- and plus 10-mesh. This latter specification was not met by any of the test products. Furthermore, it does not appear possible that such a specification can be met on the type of ore received, because of the intimate mineralogical association as shown by microscopic examination and in photomicrographs (figs. 1 and 2).

A weighted composite of all the concentrates produced analyzes 62.03 percent Al_2O_3, which would place this material in a class equivalent to a marketable grade of andalusite, provided that mineralogical character and refractoriness prove satisfactory. Material between 50 and 70 percent Al_2O_3 can be composited from the various lots for the refractory tests.

The distribution by weight, the chemical analyses, and specific gravities of the heads, tailings, and concentrates, are given in table 13.

Table 13. - Distribution and analyses of mill test products

Material	Weight, pounds	Chemical analyses, percent						Sp. g.	P.C.E.*
		Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O		
Concentrate	22,605	62.3	35.1	0.53	0.76	0.32	0.15	3.25	38
Coarse middling tailing	6,718	37.3	61.4	.19	.87	.66	.17	2.92	31.5
Fine middling tailing	2,706	35.4	62.9	.14	.87	.52	.16	2.90	31^+
Tailing	18,454	36.4	60.8	.19	.77	.61	.19	2.89	32.5^-
Slime	44,600	35.6	61.4	.32	.92	1.14	.17	2.87	31^-
Calculated heading	95,083	42.2	55.1	.42	.85	.79	.17	2.97	-
Heading by analysis	-	42.5	54.2	.33	.77	.73	.29	2.95	32

*Pyrometric cone equivalent.

From the table, the ratio of concentration was 4.2 to 1. A lower-grade product containing between 50 and 55 percent Al_2O_3 may prove to be suitable for certain refractory purposes. A product made by combining the concentrates and the middlings as produced in this test operation would contain about 52.5 percent Al_2O_3; such a product would total 32,030 pounds, representing a ratio of concentration of 3.0 to 1.

CONCLUSIONS

1. Over 11 tons of table concentrates, in lots containing 50 to 70 percent Al_2O_3, were made from Hawthorne, Nev., ore. These are to be used for ceramic and refractory tests to determine their value in compounding high-alumina refractories.

2. If a certain standard quality of the concentrates analyzing between 50 and 65 percent Al_2O_3 proves to be of commercial value, such a product can be produced by table concentration. A commercial plant designed to provide well-classified and steady feed rates to tables undoubtedly could produce a fairly uniform product or a series of products varying in grade.

3. Specific-gravity determinations can be made quickly; they are reliable evidence of the product grade and may be used as a method of control in tabling operations.

4. The large proportion of minus 200-mesh fines produced by grinding suggests the possibility that additional recovery might be made by flotation on this material, provided such a product would have value. The formation of excessive amounts of fines in grinding is apparently an inherent characteristic of the ore, which is a mixture of hard and soft minerals, most of them extremely fine-grained.

5. Economic evaluation of a process for producing concentrates from Hawthorne ore by table concentration will depend upon the outcome of ceramic and refractory tests. Before such an appraisal can be made, the value and grade of a standard concentrate, as well as the use-value of any substandard byproduct, must be determined.

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MINERAL TESTING LABORATORY
WESTERN MACHINERY COMPANY

March 24, 1954
Technicians: J. V. Hill
P. A. Boukind

Project L-343
Samples 1, 2 & 3

Preliminary Heavy-Liquid and Heavy-Media Separation Tests on Samples of Andalusite-Corundum Ore, Submitted by Coranda Corporation, San Jose, California, from a Deposit near Hawthorne, Nevada.

Introduction:

Three samples of andalusite-corundum ore from near Hawthorne, Nevada were delivered to the laboratory by Messrs. J. H. Rodda and R. B. Holt, August 21, 1952. The samples were received partially as loose lumps and partially in canvas bags. The sample labeled "Bismark Andalusite" (WEMCO -1) weighed about three hundred pounds and the samples labeled "Bismark Diaspore" (WEMCO -2) & "Green Talc" (WEMCO -3) each weighed about four hundred pounds.

These samples were reportedly obtained from the Coranda Corporation property near Hawthorne, Nevada.

Although testing, as directed under this project by the Coranda Corporation, was complete October 10, 1952, the product analyses were not complete enough for preparation of a formal report until this date.

Purpose of Project:

Previous testing of other samples from this property by the United States Bureau of Mines, as reported in "War Minerals Report 388, May 1945" and a letter of March 14, 1945 from Mr. H. G. Peale to Mr. Glenn C. Allen, indicated that Heavy-Media Separation could be utilized for concentration. The Coranda Corporation, in submitting

new samples to the Western Machinery Company Laboratory, wished to verify the general conclusion that Heavy-Media Separation could be used for Concentration of material presently available at the property.

At a later date, after testing under this preliminary project was complete, the client informed our laboratory that their primary interest was in the-3 sample. Therefore, most of the conclusions from the preliminary test results and recommendations for additional testing are based on the proposed treatment of material as represented by this particular sample.

SUMMARY of PROJECT TESTING and CONCLUSIONS:

General

Heavy-liquid and laboratory Heavy-Media tests on the minus ½ inch plus 10 mesh portion of these samples, after crushing to minus ½ inch, indicated that each of these samples could be concentrated by the Heavy-Media Sep ration process. The Al_2O_3 analyses and weight percents of the sink products could be varied over a considerable range simply by varying the specific gravity of the liquid or media used for separation.

It is understood that the final acceptability of any of these test products, as raw material for the production of refractories, will be determined by the client, and that all conclusions are based on the treatment of material as represented by the submitted samples.

All results were similar to those obtained by the United States Bureau of Mines during the above-mentioned test programs wherein similar methods of concentration were used.

Referring particularly to Sample- 3 test results, as shown

in Table V and in Figure I, it is readily apparent that Heavy-Media Separation could be used to produce a hi-grade (47.87% Al_2O_3 or higher - by raising the specific gravity) Coarse "Sink" Product, and a Coarse Middling (36.98% Al_2O_3). Exact conditions and process refinements such as optimum feed top size or separatory specific gravities as well as further treatment required to concentrate the alumina minerals contained in the Coarse Middling and fines (-10 mesh), can be determined by additional testing as recommended in this report.

Sample -1

"Bismark Andalusite"

The heavy-liquid test sink products (See Table III) which assayed from 51.06 to 54.25 percent Al_2O_3, represented from 79.0 to 61.2 percent of the total sample weight, and contained from 83.7 to 68.9 percent of the total Al_2O_3.

A Heavy-Media Separation test (See Table VII) verified these results in part in that similar products were made. The conditions of this test were such that the gravity of separation was apparently nearly the same as the media specific gravity at the top of the separatory vessel.

A heavy-liquid study on one of the float products of this test, as directed by the client, indicated that the gravity of separation was somewhat higher than the top specific gravity in the separatory vessel. This is strictly an indication though, as a complete determination would require heavy-liquid testing of each product in at least 5 different specific gravity liquids or medias.

Sample -2

"Lamark Diaspore"

Heavy-liquid test sink products (See Table IV) obtained from this sample assayed from 54.19 to 56.51 percent Al_2O_3, represented from 63.7 to 49.5 percent of the total sample weight, and contained from 70.9 to 57.5 percent of the total Al_2O_3.

Results of the one Heavy-Media Separation test (See Table VIII) made on this sample were not conclusive. The product analyses and weights did not correlate with the product analyses and weights obtained in the heavy-liquid test. This apparent discrepancy in results should be checked by repeating these tests on a larger sample.

The heavy-liquid study on one of the float products of this test, as directed by the client, resulted in similar indications to those obtained by similar testing of a Heavy-Media product from Sample -1. The indicated specific gravity of separation was even higher in this case.

Sample -3

"Green Talc"

This sample was tested with heavy-liquids only. Although the Al_2O_3 analyses of the sink products obtained from this test were not as high as those of the sink products from Samples -1 and -2, definite concentration was effected. The conditions and results of this test are shown in Table V and clearly illustrated in the self-explanatory "Possible Flowscheme" Figure I.

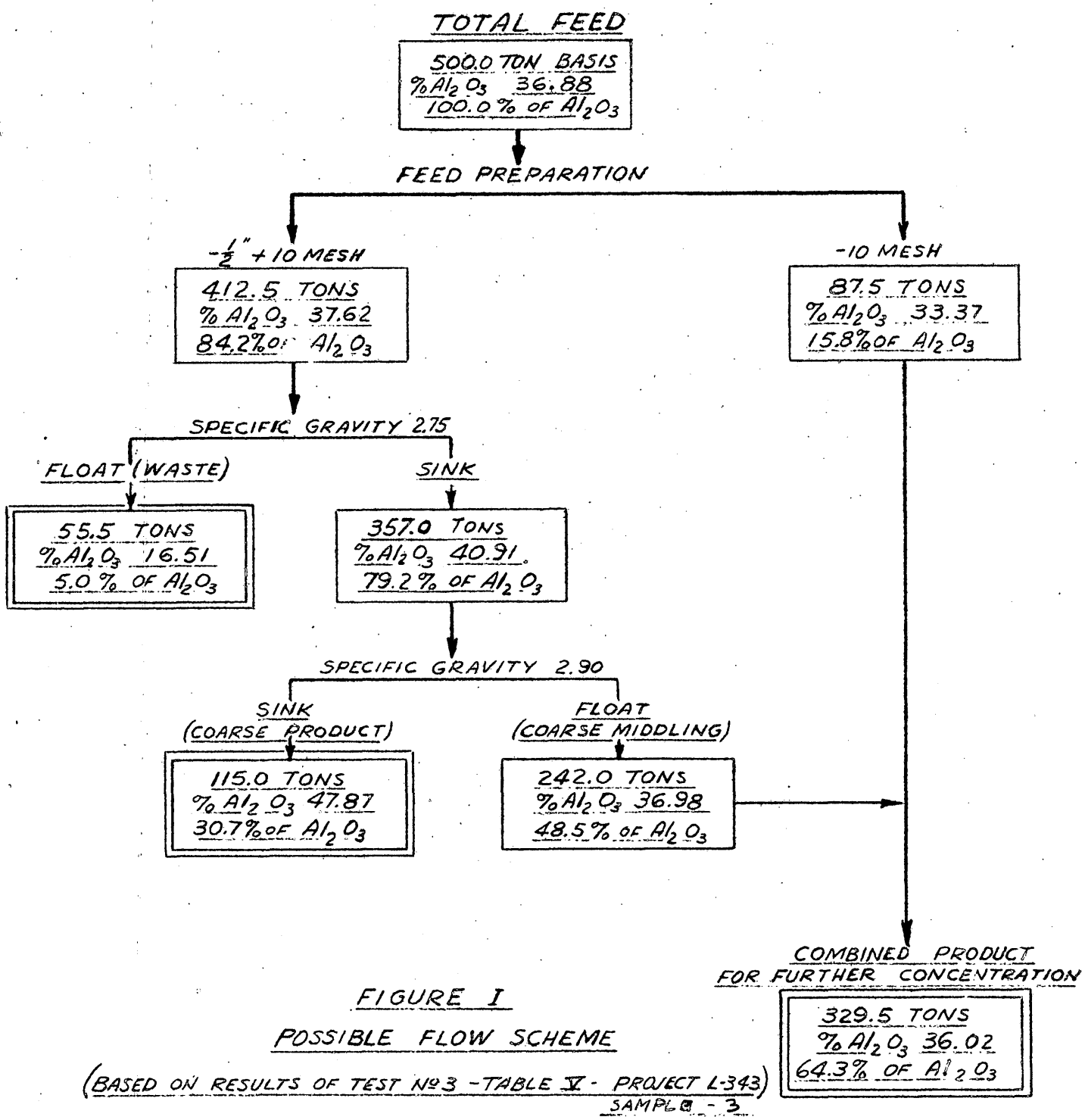

FIGURE I

POSSIBLE FLOW SCHEME

(BASED ON RESULTS OF TEST Nº 3 - TABLE V - PROJECT L-343)
SAMPLE - 3

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SAN FRANCISCO **WESTERN MACHINERY COMPANY** CALIFORNIA

COPYRIGHT 19____

DATE	3-24-54	MACHINE		SPE-94 ORDER	
SCALE	—	SIZE	TYPE		
DRAWN	J.V. HILL TEL	PARTS	FLOW SHEET	ISSUED	
CHK'D	L.A.O.			LIST	80972
APPR.					

PRINTED ON DIEPO 1000H CLEARPRINT

Recommendations:

1. Product specifications should be determinated by the client as a guide in the conduct of future testing.

2. A decision should be made as to which sample or combination of samples will be representative of the material to be produced at the property so this sample or composite may be used for future testing.

3. Detailed heavy-liquid tests should be made on separate portions of the sample or samples to be tested, each portion being crushed to a different top size before testing so the optimum top size for economical liberation and concentration can be determined.

4. Detailed Heavy-Media Separation tests should be made on separate portions of the sample or samples, crushed to optimum top size, as determined under point 3 above. Each portion should be tested at a different media specific gravity and each sample portion tested should be of sufficient weight that enough sink and float products will be made for rerunning at several other media specific gravities. This procedure would permit the verification of the "Possible Flowscheme" shown in Figure I.

5. Concentration tests should be made on the middling produced by, and the fines not tested under, point 4 above. These tests should include investigation of crushing, grinding, sizing by classification or screening, gravity methods and froth flotation.

Sample History:

Description and Analysis

The samples, as originally received, were primarily boulders from one to two feet in diameter. Since all of the samples were very hard and the laboratory equipment was too small to crush this size material, the client had the samples crushed to approximately minus 3 inch.

All of the samples contained varying amounts of andalusite, corundum (some large-approximately ½ inch diameter crystals), diaspore (some distinctive radiated crystals), pyrophyllite, mica and quartz. The U. S. Bureau of Mines, Boulder City, Nevada, in an examination of other samples from this property, have also found the mineral halloysite as "green dense talc-like material."

These samples, as previously mentioned, were all classed as "very hard", and contained very little fines upon receipt. Partial size analyses (See Table I) on the samples after crushing to minus ½ inch in preparation for testing, indicated that Sample -2 was softer than either Samples -1 or -3. The client reported that these materials, as eventually produced at the property, would probably contain more natural fines than these samples - particularly Samples -1 and -2.

TABLE I
Size Analyses of Samples
After Crushing to Minus ½ inch

Product	Percent Weight Sample -1	Sample -2	Sample -3
Total Sample	100.0	100.0	100.0
-½" + 10 mesh	85.0	68.4	82.5
-10 mesh by 0	15.0	31.6	17.5

In preparation for testing, each sample was stage crushed to minus ½ inch and the crushed product screened on a 10 mesh sieve. The oversize from this screening (½ inch by 10 mesh) and the undersize (10 mesh by 0) were submitted separately for analysis. The results of these analyses and a calculated analysis of each total sample are shown in Table II. Except as noted, all analyses were made by Pittsburgh Testing Laboratory, San Francisco California.

TABLE II

A - Reported Chemical Analyses of ½ inch by 10 mesh portion of Sample

Item	Assay Percent Sample -1	Sample -2	Sample -3
Silica (SiO_2)	46.00	41.33	58.48
Alumina (Al_2O_3)	49.05	52.20	35.18
Iron Oxide (Fe_2O_3)	-	-	0.54
Titanium Oxide (TiO_2)	-	-	0.89
Calcium Oxide (CaO)	-	-	Nil
Magnesia Oxide (MgO)	-	-	Nil
Sodium Oxide Na_2O))	-	-	0.11
Potassium Oxide (K_2O)	-	-	2.72
Boron (B)	-	-	0.012
Loss on Ignition	-	-	2.40
R_2O_3	49.42	54.56	-

B - Reported Chemical Analysis of 10 mesh by 0 portion of Samples and Calculated Analysis of Total Samples

Sample Portion	Weight %	Assay% Al_2O_3	% Distribution Al_2O_3
Sample -1 Total	100.0	48.17	100
½" by 10m	85.0	49.05	88
10m by 0	15.0	39.13*	12
Sample -2 Total	100.0	46.66	100
½" by 10m	68.4	52.20	74
10m by 0	31.6	39.7 *	26
Sample -3 Total	100.00	36.88	100
½" by 10m	82.5	35.18	84
10m by 0	17.5	36.88*	16

* These assays reported by Corando Corporation.

Preparation for Testing

Samples -1 and -2, as delivered after primary crushing, were each mixed and riffled in half. One of each half was combined into a -1, -2 composite which was not tested under this project. The other half of each sample and the total of Sample -3 were each stage crushed to minus ½ inch and representative portions riffled out for testing. Individual portions for testing were dry screened and washed on a 10 mesh sieve. The oversize, ½ inch by 10 mesh, to be used as feed to heavy-liquid tests, was dried and weighed. Feed to Heavy-Media Separation plants is nearly always wet so the portion of oversize for Heavy-Media testing was not dried.

The weight distribution of the size portions from each sample after crushing is shown in Table I.

Heavy-Liquid

Heavy-liquid tests were conducted using liquid mixtures of acetylene tetrabromide (Sp. Gr. 2.95) and carbon tetrachloride (Sp. Gr. 1.59). The sample portion to be tested was first put into the liquid having the highest specific gravity, the material that floated was removed, washed in carbon tetrachloride and returned to the next lower gravity liquid used. This procedure was repeated until the material had been tested in all the reported liquids. The resulting test products, a "sink/in" each liquid and a "float/on" the lowest gravity liquid, were then washed with carbon tetrachloride, oven dried overnight at 105° C, weighed and submitted for analysis. Detailed conditions and results of these tests are shown in Tables III, IV and V and also as supplementary tests in Table VI and VII.

Heavy-Media Separation

Heavy-Media Separation tests, on samples -1 and -2 only, were conducted in a WEMCO Laboratory Unit with a 20" diameter cone type separatory vessel. Coarse ground ("65x") ferrosilicon pulped with water was used as the media. Conditions of the tests were regulated to maintain a differential between the "top" and "bottom" specific gravities of about 0.17 points. Samples for determination of the "top" and "bottom" specific gravities were taken in the accepted manner, i.e., the "top" sample was taken from just under the media surface in the cone and the "bottom" sample direct from the "sink" airlift. Test products were washed, dried, weighed and submitted for analysis. Detailed conditions and results of these tests are shown in Tables VI and VII.

MINERAL TESTING LABORATORY
Western Machinery Company
WEMCO Division

Jack V. Hill

Jack V. Hill, Chief Technician

Perry A. Boukind

Perry A. Boukind, Technician

WESTERN MACHINERY COMPANY

Date 8/29/52 Project J-343

Engineer PAB & JVH Table No. III Test No. 1 Sample 1

HEAVY-LIQUID TEST on a representative portion of the sample stage crushed to minus ½ inch.

Product	Weight % Total	Weight % Part	Assay % Al_2O_3	Assay % SiO_2	Assay % R_2O_3	% Distribution Total Al_2O_3	% Distribution Part Al_2O_3
Calc. Sample	100.0	-	48.17	-	-	100.0	-
-10 mesh	15.0	-	39.13*	-	-	12.2	-
Assay HLT Feed	-	-	49.05	46.00	49.42	-	-
Calc HLT Feed (-½"/10m)	85.0	100.0	49.76	46.36	51.62	87.8	100.0
Sink in 2.95	61.2	72.0	54.25	42.12	56.52	68.9	78.6
(Float on 2.95) Sink in 2.90	6.9	8.1	43.10	54.66	45.00	6.2	7.0
(Float on 2.90) Sink in 2.85	4.9	5.7	40.67	55.32	43.04	4.1	4.7
(Float on 2.85) Sink in 2.80	6.0	7.1	36.11	57.26	37.80	4.5	5.1
Float on 2.80	6.0	7.1	32.69	61.84	30.08	4.1	4.6

*Assay furnished by Coranda Corporation.

Calculated combinations are shown below:

Product	% Weight Total	% Weight Part	% Assay Al_2O_3	% Distribution Total Al_2O_3	% Distribution Part Al_2O_3
2.95 Calc Float	23.8	28.0	38.24	18.9	21.4
Sink	61.2	72.0	54.25	68.9	78.6
Calc Sink &-10m	76.2	-	51.27	81.1	-
2.90 Calc Float	16.9	19.9	36.27	12.7	14.4
Calc Sink	68.1	80.1	53.11	75.1	85.6
Calc Sink &-10m	83.1	-	50.59	87.3	-
2.85 Calc Float	12.0	14.2	34.42	8.6	9.7
Calc Sink	73.0	85.8	52.28	79.2	90.3
Calc Sink & -10m	88.0	-	50.05	91.4	-
2.80 Float	6.0	7.1	32.67	4.1	4.6
Calc Sink	79.0	92.9	51.06	83.7	95.4
Calc Sink &-10m	94.0	-	49.16	95.9	-

MINERAL TESTING LABORATORY
WESTERN MACHINERY COMPANY

Date 8/29/52 Project L-3[illegible]2

Engineer PAB & JVH Table No. IV Test No. 2 Sample 2

HEAVY-LIQUID TEST on a representative portion of the sample stage crushed to minus ½ inch.

Product	Weight % Total	Weight T% Part	Assay % Al_2O_3	Assay % SiO_2	Assay % R_2O_3	% Distribution Total Al_2O_3	% Distribution Part Al_2O_3
Calc. Sample	100.0	-	48.66	-	-	100.0	-
-10 mesh	31.6	-	39.7*	-	-	25.8	-
Assay HLT Feed	-	-	52.20	41.33	54.56	-	-
Calc HLT Feed (-½"/10m)	68.4	100.0	52.79	40.85	54.44	74.2	100.0
Sink in 2.95	49.5	72.4	56.51	37.06	58.08	57.5	77.4
(Float on 2.95) Sink in 2.90	8.1	11.8	49.36	44.80	51.26	8.2	11.1
(Float on 2.90) Sink in 2.85	2.7	3.9	44.12	50.00	45.84	2.4	3.3
(Float on 2.85) Sink in 2.80	3.4	5.0	40.04	53.44	41.84	2.8	3.8
Float on 2.80	4.7	6.9	33.9	59.58	35.66	3.3	4.4

*Assay furnished by Coranda Corporation

Calculated combinations are shown below:

Product	% Weight Total	% Weight Part	% Assay Al_2O_3	% Distribution Total Al_2O_3	% Distribution Part Al_2O_3
2.95 Calc Float	18.9	27.6	43.07	16.7	22.6
Sink	49.5	72.4	56.51	57.5	77.4
Calc Sink &-10m	81.1	-	49.96	83.3	-
2.90 Calc Float	10.8	15.8	38.33	8.5	11.5
Calc Sink	57.6	84.2	55.50	65.7	88.5
Calc Sink &-10m	89.2	-	49.91	91.5	-
2.85 Calc Float	8.1	11.9	36.42	6.1	8.2
Calc Sink	60.[illegible]	88.1	54.99	68.1	91.8
Calc Sink &-10m	91.9	-	49.74	93.9	-
2.80 Float	4.7	6.9	33.83	3.3	4.4
Calc Sink	63.7	93.1	54.19	70.9	95.6
Calc Sink &-10m	95.3	-	49.39	96.7	-

MINERAL TESTING LABORATORY
WESTERN MACHINERY COMPANY

Date 8/29/52 Project L - 434

Engineer P.A.B.& J.V.H. Table No. V Test No. 3 Sample 3

Heavy - liquid test on a representative portion of the sample stage crushed to minus ½ inch.

Product	Weight			Assay %						% Distribution		
		% Total	% Part	Al_2O_3	S_iC_2					total Al_2O_3	Part Al_2O_3	
Calc Sample	8	100.0	—	36.88	—					100.0	—	
- 10 mesh	1	17.5	—	* 33.37	—					15.8	—	
Assay HLT feed		—	—	35.18	58.48					—	—	
Calc HLT feed (-½"&10)		82.5	100.0	37.62	57.98					84.2	100.0	
Sink in 2.95	2	15.1	18.3	52.75	41.28					21.6	25.7	
(Float on 2.95) Sink in 2.90	3	7.9	9.6	42.31	51.34					9.1	10.8	
(Float on 2.90) Sink in 2.85	4	11.8	14.3	37.67	56.98					12.1	14.3	
(Float on 2.85) Sink in 2.80	5	14.4	17.5	37.42	60.86					14.6	17.4	
(Float on 2.80) Sink in 2.75	6	22.2	26.8	36.30	60.96					21.9	25.9	
Float on 2.75	7	11.1	13.5	16.51	76.88					5.0	5.9	

Calculated heavy-liquid test @ 2.75 with retreatment of the "sink in 2.75" product at 2.90, as proposed by Coranda Corporation, is shown below and in figure 1:

Product		% Weight			% Assay			% Distribution		
		Total	Part		Al_2O_3			Total Al_2O_3	Part Al_2O_3	
Sample	8	100.0	—		36.88			100.0	—	
HLT feed -½" & 10 mesh	9	82.5	100.0		37.62			84.2	100.0	
Float on 2.75 (waste) @	7	11.1	13.5		16.51			5.0	5.9	
Sink in 2.75 (feed to 2.90)	2-6 inc.	71.4	86.5		40.91			79.2	94.1	
Calc sink in 2.90 (coarse conc) @	2&3	23.0	27.9		47.87			30.7	36.5	
Calc Fl on 2.90 (coarse midd) @	4,5,&6	48.4	58.6		36.98			48.5	57.6	
@ minus 10 mesh	1	17.5	—		33.37			15.8	—	
Calc Comb Float on 2.90 @ -10m	1,4,5,6	65.9	—		36.02			64.3	—	for further treatment

* Assay furnished by Coranda Corporation
@ Final Products

Date 10/10/52 Project L - 343

Engineer J.V. Hill Table No. VI Test No. 4 Sample 1

Heavy media separation test on a representative portion of the sample stage crushed to minus ½ inch.

Product	Weight			Assay %						% Distribution			
	Grams	% total	% part	Al_2O_3						total Al_2O_3	part Al_2O_3		
Calc Sample		100.0	—	47.65						100.0	—		
Minus 10 Mesh		15.0	—	* 39.13						12.3	—		
Assayed H.M.S. feed	18932	—	100.0	* 49.05						—	—		
Calc H.M.S. feed		85.0		49.15						87.7	100.0		
Sink in 3.09	3876	17.4	20.5	59.0						21.6	24.6		
(Float on 3.09) Sink in 2.93	6712	30.1	35.4	* 50.5						31.9	36.4		
Float on 2.93	8344	37.5	44.1	* 43.5						34.2	39.0		
Total Calc. Sink in 2.93	10588	47.5	55.9	53.6						53.5	70.0		

Minus ½ inch plus 10 mesh was run at a Top Specific Gravity of 3.09 (bottom 3.26). the float from this was re-run at a top specific gravity of 2.93 (bottom 3.10). Coarse ferrosilicon medium was used in the 20 inch laboratory cone.

Heavy liquid study on the "Float on 2.93" from the above test is shown below:

Products		Weight			% Assay				% Distribution		
		% Total	% Part		Al_2O_3	Spec. Grav.			total Al_2O_3	Part Al_2O_3	
Calc Total Float on 2.93		100.0			43.34	2.95			100.0	—	
Calc Total plus ¼ inch		72.5	100.0		42.91				71.8	100.0	
Sink in 2.95		25.1	34.6		* 48.30	3.04			27.9	38.9	
Float on 2.95		47.4	65.4		* 40.1	2.89			43.9	61.1	
Calc total minus ¼ inch		27.5	100.0		44.47				28.2	100.0	
Sink in 2.95		13.6	49.6		* 48.32	3.04			15.4	53.7	
Float on 2.95		13.9	50.4		* 40.7	2.86			13.1	46.3	
Calc combined Sink in 2.95		38.7	—		48.24	3.04			43.0	—	

* Assays furnished by Coranda Corporation

Date October 10, 1952 Project L-343

Engineer J.V. Hill Table No. VII Test No. 5 Sample 2

HEAVY MEDIA SEPARATION TEST ON A REPRESENTATIVE PORTION OF THE SAMPLE STAGE CRUSHED TO MINUS 1/2 INCH.

Product	Weight			Assay%						% Distribution			
	Grams	% Total	% Part	Al_2O_3						Total Al_2O_3	Part Al_2O_3		
Assay Sample		--	--							--	--		
Calc. Sample		100.0	--	48.00						100.0	--		
Minus 10 Mesh		31.6	--	* 39.7						26.1	--		
Assay HMS Feed	28799	--	100.0	* 52.20						--	--		
Calc HMS Feed		68.4		51.83						73.9	100.0		
Sink in 3.12	923	2.2	3.2	* 67.40						3.1	4.2		
Float on 3.12 Sink in 2.94	5509	13.1	19.1	* 58.70						16.0	21.7		
Float on 2.94	22367	53.1	77.7	* 49.50						54.8	74.1		
Total Calc. Sink in 2.94	6432	15.3	22.3	59.93						19.1	25.9		

Minus 1/2 inch plus 10 mesh was run at a Top Specific Gravity of 3.12 (Bottom 3.27). The float from this was re-run at a Top Specific Gravity of 2.94 (Bottom 3.12). Coarse ferro-silicon medium was used in the 20 inch laboratory cone.

HEAVY LIQUID STUDY on the "FLOAT on 2.94" from the above test is shown below:

Product		% Weight		% Assay						% Distribution	
		Total	Part	Al_2O_3		Spec. Grav.				Total Al_2O_3	Part Al_2O_3
Calc Total Float on 2.94		100.0	--	49.46		2.97				100.0	--
Calc Total Plus ¼ inch		72.3	100.0	49.11						71.8	100.0
Sink in 2.95		44.2	61.1	* 54.60		3.00				48.8	68.0
Float on 2.95		28.1	38.9	* 40.5		2.90				23.0	32.0
Calc Total minus ¼ inch		27.7	100.0	50.36						28.2	100.0
Sink in 2.95		18.6	67.2	* 55.10		3.05				20.7	73.5
Float on 2.95		9.1	32.8	* 40.7		2.91				7.5	26.5
Calc Combined Sink in 2.95		62.8	--	54.74						69.5	--

* Assays furnished by Coranda Corporation

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CORANDA CORPORATION
386 Race St.
San Jose, Calif.

Nov. 3, 1953

Mr. A. C. Johnson
Department of Interior
Bureau of Mines
P. O. Box 1551
Reno, Nevada

In Re: Docket No. 2512
Contract No. IDM-E457

Dear Mr. Johnson,

Transmitted herewith is the final report of findings of exploration work on andalusite-corundum deposits located in the vicinity of Hawthorne, Mineral County, Nevada.

Diamond drilling work, consisting of 2500 feet was performed under contract by the Diamond Bit and Tool Co., San Francisco, Calif. Physical and chemical analyses of drill cores were performed by Pittsburg Testing Laboratory, San Francisco, Calif. The exploration work, including supervision of diamond drilling, geological mapping, surveying, calculation of ore reserves etc., was under the direction of Mr. L. B. Spencer, Mining and Civil Engineer, Mina, Nevada.

Sincerely yours,

CORANDA CORPORATION

J. H. Rodda

by J. H. Rodda, Pres.

R. B. Holt

by R. B. Holt, Secretary

FINAL REPORT DOCKET NO. 2512

CONTRACT NO. IDM-E457

A B S T R A C T

The Coranda Corporation controls eighteen surveyed andulusite-corundum claims, located in the vicinity of Hawthorne, Nevada. Recent exploration work has shown ore reserves in excess of 1,000,000 tons. Bureau of Mines studies plus those made by Coranda Corporation has shown that concentrate products exhibit high refractory characteristics. These deposits are of the few known commercial deposits of its size in the United States and represent a western source of alumina refractory materials.

SCOPE AND IMPORTANCE OF ALUMINA REFRACTORIES

The following information and data are offered for purposes of aiding the evaluation of the Hawthorne Refractory Ore Deposits and as a means of refering to the many sources of written work concerning the refractory industry. It is to be pointed out that there are few, if any, completely written sources of information on the refractory industry, particularly in reference to sillimanite* types of refractories. Further information may best be obtained from governmental agencies and ceramic or refractory consultants who are familiar with alumina type refractories.

The refractories industry is not considered to be one of the largest industries but it is certainly one of the most important as any process that uses high temperature conditions must depend on refractories in one form or another. Modern industry as we know it today, such as the manufacture of ferrous and non-ferrous metals, chemical and oil products, cement, power generation, etc., could not exist if refractory products were not available.

The early history of refractory usage dates back to the early ages of man and it is without doubt that the value of refractory rocks and minerals for the controlling of heat energy was quickly recognized. In spite of the early recognition of the value of refractories, their manufacture has been mainly an art until recently. Through chemistry, it was learned that oxides, silicates, carbides and nitrides of certain metals made up most of the refractory materials. Although many ingenious methods have been devised it was not until the advent of X-ray[2] studies that many minerals and substances could be identified due to their small size and indefinite composition.

Generally speaking, refractory products are made from various silicates, oxides, carbides and nitrides of metals which possess high melting or fusion points, are resistant to the chemical deterioration of combustion gases and other heat sources and must have load bearing capacity at high temperatures to withstand structural stress and strain. There are many different types of silicates and oxides that have been used in refractories manufacture. Aluminum silicates are the most commonly used raw materials and make up the chemical composition of most clays such as kaolin, bauxite, diaspore, sillimanite group minerals, etc. The oxide refractories are made up largely of magnesia, chrome, and dolime.

Moderan industry steadily is increasing its demands for furnace refractories[3] that possess a combination of high mechanical strength, low porosity and shrinkage, and resistance to abrasion at high temperatures. In many instances these demands have been fulfilled best by high alumina refractories composed predominantly of the artificial mineral compound mullite, $3Al_2O_3.2SiO_2$. Mullite is a product formed by the interaction of silica and alumina in correct proportions at relatively high firing temperatures or may be obtained as a transition product of the decomposition of minerals of the kyanite group (andalusite, kyanite, and sillimanite) at high temperatures.

High-alumina refractories are neutral[4] and they flux or form slags with difficulty; consequently, they are used widely in lead and glass furnaces, clinker-zone linings in Portland cement kilns,

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*The term sillimanite is used as a general name for the minerals andalusite, kyanite, dumorierite, topaz and sillimanite.

in boiler-furnace setting used for high-ash coals, and in blast furnace regenerators. A list of pyrometric cone equivalent values and chemical analyses of various grades of typical high alumina brick are given in table 1.[5]

HIGH ALUMINA CLASS	Alumina Range 50	60	70	80
	Analysis, %			
Al_2O_3	51.5	60.8	70.6	79.4
SiO_2	41.9	33.8	22.8	15.8
TiO_2	2.7	3.0	3.7	2.1
Fe_2O_3	1.8	1.7	1.8	1.7
CaO	.1	.2	.2	.2
MgO	.5	.3	.3	.3
Alkalies	1.2	1.1	1.0	1.0
P.C.E. Cone Number	34-35	36-37	38	39
Temperature equivalent, °C	1,773	1,815	1,835	1,865

The far western area of the United States has relatively few deposits of minerals containing enough alumina for use in the manufacture of high alumina refractories.[6] The common fact that western sources of high alumina minerals are limited, has had a disturbing influence on refractories manufacturers, who have been trying to keep pace with western industrial expansion needs. Furthermore, known deposits of sillimanite minerals of commercial importance are very limited in number for the entire United States.

It is not the purpose of this report to delve into the many ramifications of the refractory industry; however it is important to point out various trends and present day facts that enter into the evaluation of raw material resources. The present day supply of high-alumina minerals suitable for use in refractories is becoming less available.[7] It is generally known that good quality diaspore deposits in the midwestern regions are becoming depleted and substitute materials are being investigated. Bauxite has been used for some time but it has caused difficulty in refractories manufacture and the resultant products have been found inferior in many cases.[8] A combination of sillimanite minerals and corundum or diaspore[9] has been found to fulfill many of the properties of the diaspore type but the domestic supply of sillimanite minerals has heretofore been limited as previously mentioned. Due to uncertainty of supply and high prices, the expansion of sillimanite minerals usage has been limited. Some measure of the importance of these minerals is indicated by the fact that during World War II and the Korean War the government placed them in one of the highest strategic lists.

Mode of Occurance[10]

Andalusite--Andalusite is characteristically found in argillaceous slates and schists produced by contact-metamorphic action of granitic intrusives. Dioritic and more basic intrusives also may cause its formation. It is sometimes found within granite bodies, especially those of the two-mica variety. Mica schists and gneisses also may harbor it. It occurs as lenses and pockets in pegmatities and quartz masses and as replacement bodies produced by pneumatolytic action of residual magmatic solutions. It is not a typical product of regional metamorphism. It commonly occurs as long, prismatic crystals of nearly square cross section. Even in slates and schists, it sometimes grows to large size. The chiastolite variety featuring carbonaceous impurity arranged in a cross is typical of impure slates and schists. Large

crystal are usual in pegmatites and lenses in quartz and coarse, columnar crystal groups are not uncommon. A massive, granular, anhedral structure is also sometimes shown. Common associates are quartz, muscovite, pyrophyllite, diaspore, topaz, garnet biotite, tourmaline, lazulite, rutile, dumortierite, and sometimes sillimanite and kyanite.

Composition and Structure[11]

The sillimanite group includes andalusite, kyanite, and sillimanite, all having the same chemical composition ($Al_2O_3SiO_2$) but different crystallographic, physical, and optical properties. Two other minerals, because closely allied in composition and thermal behavior, are also included in the group; that is, dumortierite and topaz, with the formulas $8Al_2O_3B_2O_3 6SiO_2H_2O$ and $Al_2(F,OH)_2SiO_4$, respectively. A sixth mineral, mullite ($3Al_2O_3 2SiO_2$) is formed by heating any of the other five to high temperatures: It must also be included, since its properties account for the merits of the group as ceramic raw materials. In the industry, the term "sillimanite" is often loosely used to indicate any of these minerals or their products. The aluminum silicate composition gives chemical stability important both in industrial use and in natural concentration of the minerals.

All these minerals crystallize in the orthorhombic system except kyanite, which is triclinic. Their internal structures are well understood and fairly complete X-ray data have been presented 38,149 Their x-ray patterns, obtained with an x-ray spectrometer, are reproduced in Fig. 1. Only sillimanite and mullite show similar patterns due to their very close structural similarity. 16, 89, 124 The existence of mullite was long overlooked because of this similarity, reflected also in similar optical properties. Laboratory study of the system $Al_2O_3SiO_2$ led to the discovery of the compound $3Al_2O_3 2SiO_2$, and to the proof that it rather than sillimanite is present in porcelain.[13] It was found in nature in the reexamination of some fused argillaceous sediments earlier described from the Isle of Mull, and was therefore named mullite.[14]

Physical and Optical Properties[12]

The ordinary physical properties usually suffice to distinguish the individual minerals, except when intimately intergrown with other minerals. Evaluation of such mixtures is often aided by determining the specific gravity,[56,118] the calcined appearance,[36] or the fluorescent response,[34] of typical lumps of the ore. The use of gravity separation during miscroscopic analysis of such ores has been described.[35] Hardness, coupled with chemical stability, leads to the preservation of placer deposits and residual boulders. Physical properties important in the beneficiation of impure ores are specific gravity, nonmagnetic and dielectric properties, and selective response to wetting agents.

Comparison of the optical properties of sillimanite and mullite makes it clear why the mullite in porcelain was long mistaken for sillimanite. Optical properties are useful in identifying the minerals in ore samples; they also permit rough quantitative analysis of the powdered ores, thus giving rapid checks on the uniformity of successive shipments. Diffraction patterns obtained with an x-ray spectrometer can be used to a like end. In contrast, chemical analysis gives no direct information on the minerals present or their proportions but it gives such useful data as the $Al_2O_3SiO_2$ ration and the amounts of undesirable iron oxide, titania, and alkalies.

Thermal Properties[13]

Many studies have been made of the thermal behavior of the sillimanite minerals.[13,15,19,41,79,98,102,146,153] The principal results are summarized in Table 1. Behavior on heating is of paramount importance in the industrial use of the minerals. Except for mullite, which is stable up to 1810°C, all are unstable above 1545°C and break down at or below that temperature to yield mullite and free silica, the latter probably as cristobalite. Their role as mullite formers accounts for their value in ceramic products. Mullite imparts to the products such highly desirable properties as high refractoriness, low thermal expansion with resultant resistance to heat-shock, intermediate thermal conductivity, high load-bearing ability even at high temperatures, and resistance to chemical corrosion, particularly by acid slags.

The various minerals though similar in their decomposition products, differ in the temperatures required for both incipient and rapid decomposition, in microstructures, in volume and density changes, and in the relative proportions of mullite and silica. These factors have a bearing on the choice of mineral and the preparatory treatment, if any, it receives.

There is no fixed decomposition temperature for any of the group and the rate of breakdown for a given mineral varies with grain size, time and temperature.[9,15,41,122] The ranges given in Table 1 extend roughly from the temperature of earliest breakdown to that considered adequate in commercial practice. Topaz and dumortierite are the most readily dissociated, followed in order by kyanite, andalusite, and sillimanite. In practice, andalusite has an advantage in that mullitization is gradual and progressive at commercially attained temperatures. Sillimanite is scarcely affected at such temperatures, whereas the others are too readily decomposed.[15,122]

The volume changes on calcination affect the use of the minerals. All show a decrease in density, hence an increase in volume, on calcination. For all except kyanite, the change is so slight that they are essentially volume-constant and can be used without precalcining. Kyanite undergoes a notable expansion. It is, therefore, usually calcined before use, although in some cases raw kyanite in low percentages has been tried with success. Because of the expulsion of the bulk of their volatiles, dumortierite and topaz undergo weight losses of up to 6.6 pct[15] and 16 to 21 pct,[79,102,146] respectively. Despite this, they are practically volume-constant. For topaz, precalcination to eliminate fluorine is considered necessary, and is attended by difficulties.[20,102] Once completely mullitized, no further volume change occurs in any of the minerals, aside from the normal thermal expansion, except coarse-bladed kyanite. Recent work by Boose has given further information regarding the volume constancy of topaz on calsining at 3000°F. He states that continued heating at 3000°F would be necessary to render topaz suitable for refractory use.[165]

The calcined microstructure of the minerals varies somewhat. Kyanite, dumortierite, and topaz give an interlacing aggregate of mullite needles, said to promote mechanical strength. Andalusite and sillimanite show a parallel orientation of mullite crystals. Kyanite, on account of its expansion, gives a highly porous product. On the basis of the density decrease, this expansion should be about 16 pct but because of cracking and exfoliation it amounts to as much as 200 pct.[79] This isparticularly true of the coarse, bladed domestic kyanite, which consequently has a high shrinkage and is difficult to bond in use. In contrast to the soft, friable grog of this type of kyanite, massive India kyanite yields a hard, tough grog of

considerably lower porotity.[79] The small amount of fluorine remaining in calcined topaz may have a beneficial mineralizing action in use.[102] The boric oxide released into dumortierite-bearing refractories on firing is believed to have similar merit.[118]

The modified $Al_2O_3SiO_2$ diagram is useful in evaluating the refractoriness of aluminum silicate minerals and mixtures. The superiority of andalusite, kyanite, or sillimanite over kaolinite or pyrophyllite is clear from a comparison of the relative amounts of siliceous liquid formed at or about 1545°C. Dumortierite and topaz have the advantage that their $Al_2O_3SiO_2$ ratio more closely approaches that of mullite, which gives no liquid up to 1810°C. The still greater refractoriness of such aluminous mixtures as electrocast mullite-corundum, calcined diaspore-clay or bauxite, and andalusite-diaspore mixtures is also apparent.

Certain other properties that are either strictly thermal or related to their use at high temperatures are highly significant in practical application. Electrical resistivity tests indicate that kyanite, sillimanite, and andalusite stand in that order as regards merit in this property.[66] Pertinent comparative data show the relative merits of mullite and other types of insulating materials as regards thermal expansion, resistivity, and thermal conductivity.[119]

Mineral Dressing

Mineral dressing techniques for treating and for concentrating sillimanite minerals vary depending on the mineral complexity and dissemination. Important physical properties that are used for concentrating have already been mentioned under physical and optical properties. Degree of expansion of the minerals in question must also be considered to determine whether calcination of products must be performed prior to use in ceramic or refractory manufacture. Purity of the ore obviously determines the degree and method of concentration. For instance, the White Mountain deposits controlled by Champion Sillimanite, Inc. are not concentrated excepting hand picking of ore as it is mined. Unfortunately, these deposits are quite limited as various economic factors such as accessibility and quantity of the deposits prevents their use as major source of refractory raw materials.

A typical mineral dressing system is described in the "Handbook of Mineral Dressing" by Taggart[14] for low grade kyanite ore. The feed averages 15% kyanite with varying amounts of garnet, quartz, mica and pyrite. Further written description of this method is given in "Industrial Rocks and Minerals".[15] The usual impurities and/or associated harmful minerals can easily be removed by making use of magnetic or wetting properties. Calcination methods are usually determined by the physical properties of the products. Due to the hardness of final products some care must be exercised in crushing and grinding with provision for removing abraded iron from ground products. Stone lined mills are usually used for fine grinding.

Production and Consumption

It is to be pointed out that there are few if any complete sources of information on production and consumption of sillimanite minerals. Statistics are not given to any great extent

which is peculiar to many besides the refractories industry, and furthermore no figures have been released since 1943.[16] Kyanite remains the preferred source material for mullite refractories due to availability. During World War II increased dependence on domestic sources led to an intensification of the search for higher grade deposits of sillimanite minerals. Domestic output was greatly stimulated because of the uncertainty of supplies from India. The trend in production and imports of kyanite in the United States is known to have increased very steadily since 1940, however actual volume is not known for reasons given above and the fact that output rarely reaches the open market until fabrication. The Kyanite Mining Corporation markets raw and calcined Virginia kyanite in grog sizes of 35 mesh and less. The Chas. Taylor Sons Co. distributes raw lump and ground calcined India kyanite. The Golwynne Chemical Co. and Mullite Refractories Co. market both India and Africa Kyanite ores. The P. B. Sillimanite Co. Ltd. distributes both India and Africa kyanite ores and products in Great Britain. The Champion Spark Plug Co. has marketed andalusite refractories as Champion Sillimanite, and its spark plug insulators bear the name, "Champion". The New Castle Refractories Co. markets kiln furniture containing andalusite. Sillimanite minerals are incorporated in products by the Richard C. Remmey Son Co., Laclede-Christy Clay Products Co., General Refractories Co., and Denver Fire Clay Co. The Coors Porcelain Co. and A. P. Green Fire Brick Co. are also included in this group.

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FINAL REPORT DOCKET NO. 351 - CONTRACT NO. IDM-E457

HAWTHORNE ANDALUSITE - CORUNDUM DEPOSITS
THE HAWTHORNE MINING DISTRICT
MINERAL COUNTY, NEVADA

The Hawthorne Andalusite and Corundum deposits are held by the Coranda Corporation and consist of the following unpatented lode claim groups: The Green Talc Group; the Victory Group; the Bismark Group; and the Deep Mines Group. All of these are located from within eight to twelve miles by road from the town of Hawthorne, Nevada. This area is located East of the southern end of Walker Lake and lies in general within the three townships of Range 31 and 32 East, Township 8 and 9 North, M.D.M., in Mineral County, Nevada. Three of the claim groups, the Green Talc, Victory and Bismark, lie on the southern slope of the Gillis Range of hills. The fourth group, consisting of the Deep Mine Claims, lies between Hawthorne and within a mile of the Southern Pacific Railway, which traverses the central part of Soda Springs Valley.

Location and Legal Description

ALTO AND GREEN TALC CLAIM GROUP:

Hawthorne Mining District, Mineral County, Nevada, approximately 5 miles in a northeasterly direction from Thorne, Nevada, in Township 9 North Range 31 East, in Sections 22, 23, 26, and 27. The claim group consists of Green Talc and Green Talc 1 through 4, the Green Talc Extension and the Alto Claim.

The Alto Claim is located as follows: Corner No. 1 is located 750 feet S47°00"W from the NE Corner of Section 27; thence 1500 feet N77°52"E to Corner No. 2; thence 600 feet S12°08"E to Corner No. 3; thence 1500 feet S77°52"W to Corner No. 4; thence 600 feet N12°08"W to Corner No. 1, the starting point.

The Green Talc Claim No. 1 is located as follows: Corner No. 1 coincides with Corner No. 1 of the Alto Claim; thence 895 feet S77°52"W to Corner No. 2; thence 607 feet N3°14"W to Corner No. 3; thence 897 feet N77°52"E to Corner No. 4; thence 607 feet S3°14"E to Corner No. 1, the starting point.

The Green Talc Claim No. 2 is located as follows: Corner No. 1 coincides with Corner No. 1 of the Alto Claim; thence 607 feet N3°14"W to Corner No. 2; thence 1500 feet N77°52"E to Corner No. 3; thence 607 feet S3°14"E to Corner No. 4; thence 1500 feet S77°52"W to Corner No. 1, the starting point.

The Green Talc Claim No. 3 is located as follows: Corner No. 1 is 262.6 feet N32°57"E from the SW Corner of Section 23; thence 1500 feet S77°52"W to Corner No. 2; thence 398 feet N3°14"W to Corner No. 3; thence 857 feet N63°50"E to Corner No. 4; thence 701 feet N77°52"E to Corner No. 5; thence 607 feet S3°14"E to Corner No. 1, the starting point.

The Green Talc Claim No. 4 is located as follows: Corner No. 1 coincides with Corner No. 1 of the Green Talc Claim No. 3; thence 607 feet N3°14"W to Corner No. 2; thence 1500 feet N77°52"E to Corner No. 3; thence 607 feet S3°14"E to Corner No. 4; thence 1500 feet S77°52"W to Corner No. 1, the starting point.

The Green Talc Extension is located as follows: Corner No. 1 coincides with Corner No. 1 of the Alto Claim; thence 600 feet S12°08-E to Corner No. 2; thence 1500 feet S77°52-W to Corner No. 3; thence 600 feet N12°08-W to Corner No. 4; thence 1500 feet N77°52-E to Corner No. 1, the starting point.

The Green Talc Claim is located as follows: Corner No. 1 coincides with Corner No. 2 of the Green Talc Claim No. 1; thence 831 feet S77°52-W to Corner No. 2; thence 607 feet N3°14-W to Corner No. 3; thence 832 feet N77°52-E to Corner No. 4; thence 607 feet S3°14-E to Corner No. 1, the starting point.

BISMARK GROUP:

Hawthorne Mining District, Mineral County, Nevada; approximately 8 miles due East of the Town of Thorne, Nevada, in Township 9 North Range 32 East, in Sections 31 and 32.

The Bismark Claim is located as follows: Corner No. 1 is located approximately 870 feet due South and 425 feet due East of the NE Corner of Section 32; thence 705 feet S57°15-W to Corner No. 2; thence 600 feet N7°00-E to Corner No. 3; thence 705 feet N57°15-E to Corner No. 4; thence 600 feet S7°00-W to Corner No. 1, the starting point.

The Bismark Claim No. 1 is located as follows: Corner No. 1 is located 870 feet due South and 425 feet due East of the NW Corner of Section 32; thence 600 feet N7°00-E to Corner No. 2; thence 452 feet N57°15-E to Corner No. 3; thence 987 feet 383°00-E to Corner No. 4; thence 600 feet S7°00-W to Corner No. 5; thence 987 feet N83°00-W to Corner No. 6; thence 452 feet S57°15-W to Corner No. 1, the starting point.

The Bismark Claim No. 4 is located as follows: Corner No. 1 is located 870 feet due South and 425 feet due East of the NW Corner of Section 32; thence 795 feet N57°15-E to Corner No. 2; thence 600 feet S7°00-W to Corner No. 3; thence 1500 feet S57°15-W to Corner No. 4; thence 600 feet N7°00-E to Corner No. 5; thence 705 feet N57°15-W to Corner No. 1, the starting point.

DEEP MINES GROUP:

Hawthorne Mining District, Mineral County, Nevada; approximately 7 miles southeasterly of Thorne, Nevada, and approximately 8 miles in a notheasterly direction of Hawthorne; located in Township 8 North Range 31 East, M.D.M., in Sections 13, 14, 23 and 24.

The Deep Mine Claim is located as follows: Corner No. 1 is located approximately 650 feet N35°00-W from the S. E. Corner of Section 14; thence to Corner No. 2, 1500 feet N51°00-W; thence 600 feet N39°00-E to Corner No. 3; thence 1500 feet S51°00-E to Corner No. 4; thence 600 feet S39°00-W to Corner No. 1, the starting point.

Deep Mine No. 1 Claim is located as follows: Corner No. 1 is located approximately 650 feet N35°00-W from the SE Corner of Section 14; thence 600 feet N39°00-E to

Corner No. 2; thence 1500 feet S51°00"E to Corner No. 3; thence 600 feet S39°00"W to Corner No. 4; thence 1500 feet N51°00"W to Corner No. 1, the starting point.

VICTORY GROUP:

Victory Claim No. 1 is located as follows: Corner No. 1 is located 2,050 feet due South of the Northwest Corner of Section 25, Township 9 North Range 31 East in the Hawthorne Mining District, Mineral County, Nevada. From Corner No. 1, thence 600 feet N25°00"E to Corner No. 2; thence 748 feet S69°56"E to Corner No. 3; thence 752 feet S41°00"E to Corner No. 4; thence 600 feet S25°00"W to Corner No. 5; thence 752 feet N41°00"W to Corner No. 6; thence 748 feet N69°56"W to Corner No. 1, the starting point.

Victory Claim No. 2 is located as follows: Corner No. 1 coincides with Corner No. 1 of Victory Claim No. 1; thence 1500 feet N70°56"W to Corner No. 2; thence 600 feet N25°00"E to Corner No. 3; thence 1500 feet S70°56"E to Corner No. 4; thence 600 feet S25°00"W to Corner No. 1, the starting point.

Victory Claim No. 3 is located as follows: Corner No. 1 coincides with Corner No. 2 of Victory Claim No. 2; thence 392 feet S83°10"W to Corner No. 2; thence 1104 feet N89°47"W to Corner No. 3; thence 600 feet N25°00"E to Corner No. 4; thence 1104 feet S89°47"E to Corner No. 5; thence 392 feet N83°10"E to Corner No. 6; thence 600 feet S25°00"W to Corner No. 1, the starting point.

Victory Claim No. 6 is located as follows: Corner No. 1 coincides with Corner No. 3 of Victory No. 3; thence 450 feet N78°57"W to Corner No. 2; thence approximately 730 feet N67°00"W to Corner No. 3; thence 600 feet N25°00"E to Corner No. 4; thence approximately 730 feet S67°00"E to Corner No. 5; thence 450 feet S78°57"E to Corner No. 6; thence 600 feet S25°00"W to Corner No. 1, the starting point.

Victory Claim No. 4 is located as follows: Corner No. 1 is 400 feet N41°00"W of Corner No. 3 of Victory Claim No. 1; thence 1488 feet N81°00"E to Corner No. 2; thence 600 feet S41°00"E to Corner No. 3; thence 1488 feet S81°00"W to Corner No. 4; thence 200 feet N41°00"W to Corner No. 3 of Victory Claim No. 1, the starting point.

Victory Claim No. 5 is located as follows: Corner No. 1 coincides with Corner No. 2 of Victory Claim No. 4; thence 700 feet N74°27"E to Corner No. 2; thence 700 feet N77°15"E to Corner No. 3; thence 600 feet S41°00"E to Corner No. 4; thence 700 feet S77°15"W to Corner No. 5; thence 700 feet S74°27"W to Corner No. 6; thence 600 feet N41°00"W to Corner No. 1, the starting point.

LOCATION OF PROPERTY

The Coranda Corporation controls four claim groups, namely, the Green Talc, Victory, Bismark and Deep Mines. The first three groups are located in the extreme southeasterly portion of the Gillis Mountain Range. The Deep Mines Group is located in the extreme northeasterly outliers of the Excelsior Mountain Range. The first three named claim groups lie in a line which is approximately parallel to and at a distance of approximately four miles from the Southern Pacific Railway. All of the above claims are to be served by the Corporation's four surveyed mill sites, which are centrally located and adjoin the Southern Pacific Railway. (See Plan Map). The intervening terrain is gently rolling with a general downward slope towards the railway.

ECONOMIC FACTORS

The highway and rail net is excellent from the standpoint of commercial exploitation. Rail terminal facilities exist at Thorne, which lies northwest of the claim groups; however, the most practical terminal or siding point would be at the location of the mill sites. Road facilities to the mill sites would be considerably shorter and more economic from an operations standpoint.

The road serving the Green Talc group is for the most part controlled and maintained by the county, whereas the remaining portion is gravelled. The roads serving the Victory and Bismark groups are unimproved. The Deep Mines Group is served by a paved road excepting 200 yards.

POWER

Power for the territory is generated by the Mineral County Power System, with main offices in Hawthorne. A 33,000 volt high line passes within 0.2 mile of the south end of the Deep Mines group. A continuation of this line passes over the mill sites owned by the Coranda Corporation.

WATER

Application for water rights has been applied for through the State of Nevada and has been approved. Water usage in excess of 500 gallons per minute is being allowed.

PREVIOUS HISTORY AND DEVELOPMENT

The original andalusite-corundum deposit, the Green Talc group, was discovered in 1929, whereas the Deep Mines, Victory and Bismark groups were discovered in latter years. Little development or mining work was performed on any of the claim groups up to 1945, excepting annual assessment work. It was learned that the ore from these deposits was not sufficiently uniform or of high enough alumina content[1,2], to be used directly in refractories manufacture. Mineralogical examination of this ore showed that it contained varying amounts of impurities and alumina content, making beneficiation necessary to remove any impurities and also to raise the alumina content. Preliminary mineral dressing tests performed by the Bureau of Mines, Salt Lake City, Utah, showed that the ore could be beneficiated by several methods.

During World War II searches and studies of domestic sillimanite deposits were greatly intensified, and one of the projects concerned the Hawthorne sillimanite deposits, which is reported in War Minerals Report 388. This work followed that performed by the Salt Lake Station and took place at the Boulder City Bureau of Mines Station. These tests utilized

tabling methods of concentration, which showed that this ore could be beneficiated; however, later work has shown much more efficient methods. A detailed discussion of this work will not be made at this time as reference, together with other material, will be given later in this report.

[1]War Minerals Report 388, Bureau of Mines, Dept. of Int., pg. 1
[2]Reconnaissance Report on Andalusite properties near Hawthorne, Nevada, Schrotes, G. Austin, Mining Eng., July 5, 1941.

TOPOGRAPHY AND CLIMATIC CONDITIONS

The Hawthorne deposits are located in the lower foothills of two mountain ranges which form the sides of the valley in which the towns of Hawthorne and Thorne are located. A plan view map included in this report shows the relative locations. Maps showing the topography and geology of the deposits are also included.

Climatic conditions in the Hawthorne area are quite favorable, as atmospheric temperatures are moderate, and the yearly moisture precipitation is limited to approximately 3 inches. Several operations are located in the area which have found that no special provisions are necessary for all year operation.

RECENT EXPLORATION AND DEVELOPMENT

During the initial stages of the investigation of the Hawthorne andalusite-corundum deposits, several factors presented themselves which have had a direct bearing on the development of the deposits. It was found that the ore was not sufficiently uniform, or of sufficient alumina content to be used directly and contained varying amounts of impurities. Mineral dressing tests showed that the ore could be beneficiated to produce a product of excellent refractory characteristics. To realize the most profitable and economic operation, it was very apparent that mass mining and beneficiation methods should be used. With consideration to the above factors a program of exploration and development was set up to determine whether ore of sufficient economic quantities was available or not. In brief, the program, which is discussed in detail below, consisted of geological mapping, exploration of the various ore bodies by diamond drilling, physical and chemical testing of drill cores, mineral dressing tests on ore from the various deposits and evaluation of the concentrates by refractory testing methods. Diamond drilling exploration and physical and chemical testing of the drill cores were carried out by means of a contract by and between Coranda Corporation and the Defense Minerals Exploration Administration, 10% and 90% of the costs being carried by Coranda Corporation and the D. M. E. A., respectively. Geological mapping of the deposits was performed by the U. S. Geological Survey and the Coranda Corporation. In addition to Bureau of Mines mineral dressing and tests on concentrates, the Coranda Corporation has had mineral dressing tests performed, thermal load tests and pyrometric cone equivalent tests made on concentrates.

GENERAL AND ECONOMIC GEOLOGY

Both the Gillis and Excelsior Mountain Ranges, in the vicinity of the claim groups, appear to be horsts or upthrown blocks, separated by a long trough-like graben or down-dropped block, now filled with talus from the boundary ranges.[1] The canyon mouths are invariably marked by long, partially dissected

alluvial fans which probably cover the topographically lower favorable ore-bearing horizons.

By and large, both of the ranges in this vicinity appear to be made up in the aggregate of a varied assemblage of metamorphic rocks. It is in these schists, quartzites, etc. that the andalusite-corundum lenses occur. It appears that these bodies were formed by contact metamorphism, brought about by igneous intrusion into argillaceous country rocks and subsequently altered by hydrothermal action.[2] There is not much reason to believe that the character of the deposits would change at depth in view of information now available.

Quartzite, quartz and meta volcanic rocks have been found to be the most common diluents; however, the meta volcanic rock is most commonly found at the fringe areas of the ore pods and lenses. In general, the ore zones do not follow a definite direction; however, they trend in a northeasterly direction, as shown on the plan view map of the diamond drill holes.

Results of diamond drilling exploration in terms of ore reserves are discussed further on in this report.

[1]Reconnaissance Report on andalusite properties near Hawthorne, Nevada, Schrotes, C. Austin, Mining Eng., July 5, 1941.

[2]War Minerals Report 388, Bureau of Mines, Dept. of Int., pg. 4.

MINERALOGY

Mineralogical analyses of the ore has been for the most part worked out at the Boulder City and Salt Lake City, Bureau of Mines Stations.[1] Recent additional information concerning the identification of halloysite by X-ray diffraction[2] has made an important bearing on mineral dressing techniques, the value of the ore, and an explanation of the thermal properties of the concentrates. Previously, it was thought that a dense-appearing green colored rock, which accompanies the ore, to be sericite; however, this rock has been proven to be halloysite. This accounts for the apparent discrepancy in War Minerals Report 388 concerning the quantity of mica present. Furthermore, this information pins down the reason why the sodium and potassium values were low, as the impure halloysite was mistaken for sericite.

The sodium and potassium found by chemical analyses is believed to be part of the composition and accounted for by the mica (missocovite) found in mineralogical studies. Mica is a commonly associated mineral in sillimanite group minerals.

Other X-ray diffraction work has shown that a common mineral in the ore to be diaspore and a minor mineral to be pyrophyllite. The diaspore was characterized as long grey prismatic crystals. The pyrophyllite appears as crystallized flower-like rosettes.

Photomicrographs of ore taken from the Green Talc and Bismark mines are shown on the opposite page. A comparison of these photographs with those illustrated in W. M. R. 388 illustrates the usual mineral dissemination that is found in the ore.

For all practical purposes the mineralogical association found in the Green Talc ore has been found to hold true in the varying grades of ore.

Mineralogical studies of various samples of Bismark ore have been made in preparation for mineral dressing tests. This work was performed at the Western Machinery Co. of San Francisco. Two types of samples were taken and were characterized as corundum and diaspore types, respectively. A photomicrograph of corundum bearing ore is shown on the opposite page. It was found that corundum and diaspore minerals were predominant with varying amounts of andalusite and lesser amounts of pyrophyllite and halloysite. Micas were found in much smaller quantities than that found in the Green Talc ore. The common diluents were found to be quartz, quartzite and meta volcanics near frings areas. Corundum mineral percentage was found to vary between 20-25% in corundum ore and diaspore mineral percentage varied to the same degree in diaspore ore. It was also found that the above types of ore occured in separate vugs and lenses varying in size from a few inches to several feet in thickness.

[1]War Minerals Report 388, Bureau of Mines, Dept. of Int., pg. 1.
[2]Letter, R. R. Lloyd, Chief Electrometalurgical Branch, Bureau of Mines, Boulder City, to Coranda Corp., May 1, 1953.

DIAMOND DRILLING EXPLORATION

The diamond drilling exploration work consisted of 2500 feet, 1600 feet of which was used on the Green Talc group and 900 feet on the Bismark group. This work, as previously stated, was carried out in conjunction with the D. M. E. A., under contract IDME-457, with a total amount of $56,000.00 being alloted. $28,750.00 of the above amount was alloted to carry out diamond drilling and engineering work, whereas the balance was alloted for chemical and physical tests of the drill cores. Diamond drilling was completed during the first half of this year, whereas chemical and physical analyses of the drill cores were completed on October 16th of this year.

The diamond drilling was performed by the Diamond Bit and Tool Co. of San Francisco, who was contracted to do this work. Physical and chemical tests of drill cores were performed by the Pittsburg Testing Laboratory of San Francisco. Considerable testing was also done by the Coranda Corp. laboratories.

For the most part BX size diamond drills were used for drilling with NX sizes being used for starting. AX size bits were used in several cases where found expedient.

Diamond drill logs of the cores are included in the latter part of this report. They were performed in conjunction with the Bureau of Mines and Mr. L. B. Spencer, Mining and Civil Engineer, who was retained by Coranda Corporation. It should be pointed out that these drill logs agree reasonably well with chemical analyses; however, some discrepancies may be noted, which is due to the difficulty involved in visual identification of the ore. Sillimanite minerals as they occur in the Hawthorne area have a varied coloring and character which is typical of these minerals.

CHEMICAL ANALYSES AND PHYSICAL TESTS

A large amount of chemical analyses and physical testing of surface samples, ore from mining pits and diamond drill cores have been performed. Initially, the Bureau of Mines performed analysis on 69 tons of Green Talc ore, which is reported in W. M. R. 388. The Bureau of Mines also analyzed one-ton samples of ore taken from the east pit (shown on topographical map) and from the West pit dump. These analyses are shown below.

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SAMPLE	Al_2O_3	SiO_2	Fe_2O_3	K_2O	Na_2O	MgO	CaO	TiO_2	Fe_2	L.O.I.
	Percent									
59 ton sample	42.50	54.20	.42	.73	.29	--	--	.77	--	2.13
Ne-30.1	41.4	55.9	.43	.44	.23	--	--	.80	--	---
Ne-30.2	44.8	51.9	.33	.42	.20	--	--	.72	--	---

The following surface samples were analyzed by Coranda Corp. and are taken from points located on the Green Talc topographical maps.

GREEN TALC:

Sample No.	Al_2O_3	SiO_2	Ign. Loss
	Percent		
GT-1	54.3	40.8	2.9
GT-2	50.5	40.9	5.3
GT-3	50.2	66.4	2.7
GT-4	26.20	44.9	7.9
GT-15	54.9	42.6	2.8
GT-16	51.5	42.8	3.40

BISMARK:

Sample No.	Al_2O_3	SiO_2	Fe	TiO_2	CaO	MgO	Na_2O	K_2O
	Percent							
S-1	53.6	42.2	.57	1.90	Nil	Nil	.20	.60
S-2	55.2	38.6	.76	0.82	Nil	Nil	.30	.67

The following tables give the chemical analyses of the drill core samples which were used in calculating ore reserves. The average chemical analyses are listed for each hole along with the hole footage covered. Reference to the footage covered by each sample may be made by referring to the tables following the chemical analyses.

GREEN TALC MINE

Hole No. 1

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
1-1	52.86	29.20	6.58	0.41	0.50	0.75	0.44	3.30	Trace	4.11
2-1	53.38	28.90	5.44	0.80	0.15	.58	.48	3.74	"	3.65
3-1	53.82	27.80	6.86	0.52	0.44	.33	.58	4.75	"	3.64
4-1	60.10	24.80	6.02	0.48	0.10	.47	.37	2.72	"	3.28
5-1	60.32	25.55	5.01	0.33	0.41	.65	.42	2.90	"	3.10
6-1	50.28	38.30	2.48	0.94	0.30	.97	.58	3.40	"	3.97
7-1	48.02	41.20	3.43	0.70	0.35	1.10	.67	5.60	"	3.94
8-1	61.58	22.40	6.64	1.17	1.25	.65	.38	2.13	"	2.43
9-1	62.64	25.70	2.81	1.00	0.22	.95	.42	3.65	"	3.10
10-1	57.96	25.70	3.61	0.40	0.32	.97	.80	6.70	"	2.97
11-1	60.56	24.00	5.35	0.64	0.27	.34	.34	3.95	"	2.55
12-1	53.70	21.40	5.08	1.07	0.25	.90	.38	2.36	"	2.94
13-1	59.64	25.30	5.15	1.09	0.63	.33	.65	3.45	"	2.38
16-1	47.74	36.90	3.48	0.44	1.05	.60	.46	3.40	"	3.93
17-1	64.70	20.30	3.80	1.04	0.32	.76	.43	4.33	"	5.99
18-1	57.22	30.50	1.69	0.78	0.34	.65	.48	2.70	"	3.67
19-1	45.64	37.80	7.90	0.95	0.33	.50	.55	4.20	"	0.28
20-1	60.98	23.25	1.48	1.47	1.87	.46	.98	4.50	"	3.09
Average	55.84	28.18	4.60	0.79	0.51	0.66	0.54	3.77		3.28

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Footage covered 21' to 185'.

Hole No. 2

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
18-2	60.48	27.30	0.94	1.15	0.10	0.15	0.52	5.15	Trace	3.40
19-2	57.00	26.90	1.25	.85	.45	.27	.73	6.90	"	3.90
20-2	55.60	29.10	1.82	.48	.52	.52	.75	6.50	"	3.42
21-2	50.28	33.00	1.70	.69	.73	.53	.91	8.10	"	3.89
22-2	51.24	31.10	1.88	.79	.84	.64	.81	7.30	"	3.68
24-2	51.90	31.65	2.13	.96	.83	.42	.91	7.40	"	3.65
26-2	56.54	23.45	8.95	.91	.57	.07	.47	4.50	"	2.81
27-2	55.42	24.70	7.80	1.15	.72	.07	.52	4.55	"	3.15
31-2	52.32	31.05	2.30	.74	.14	.14	.81	7.40	"	4.02
33-2	56.02	26.65	5.90	1.22	.24	.24	.64	5.75	"	2.98
34-2	56.48	23.85	6.70	1.15	.55	.17	.65	6.10	"	3.07
35-2	62.60	23.95	2.35	.95	.15	.07	.46	4.45	"	3.05
36-2	57.00	28.90	2.55	1.17	.41	.03	.52	4.95	"	3.17
37-2	44.12	38.05	2.30	1.12	.45	.31	.98	10.50	"	4.02
38-2	53.74	26.50	8.20	1.17	.87	.15	.45	4.70	"	2.95
39-2	57.16	26.20	2.55	1.12	.46	.19	.89	9.50	"	3.75
40-2	62.74	24.90	2.10	1.10	.08	.37	.48	4.25	"	2.66
41-2	52.50	32.40	2.35	.97	0.12	.63	.69	5.40	"	2.91
42-2	57.30	27.10	3.55	1.00	0.48	.47	.76	7.65	"	3.60
43-2	56.40	27.00	3.10	.95	0.44	.46	.58	6.10	"	3.64
44-2	53.82	28.00	3.60	.97	0.35	.78	.76	7.10	"	3.73
Total Average	55.26	28.18	3.54	0.96	0.45	.34	.66	5.91		3.40

Footage covered 130' to 183' and 205' to 282'

Hole No. 3

1-3	51.50	31.80	1.92	0.95	0.48	0.82	0.41	7.90	Trace	4.03
2-3	63.18	18.40	7.59	1.17	.38	.79	.35	2.85	"	3.82
3-3	64.70	22.60	1.32	1.01	.34	.73	.27	4.47	"	2.88
4-3	65.72	20.60	1.49	.85	.20	.28	.33	5.81	"	2.76
14-3	51.56	34.05	1.43	.05	.18	.17	.49	6.40	"	4.00
15-3	63.96	22.25	1.12	2.90	.81	.17	.58	4.00	"	2.30
16-3	58.58	30.00	1.71	1.08	.21	.30	.50	4.65	"	2.54
17-3	45.70	40.65	1.89	1.25	.38	.48	.43	4.40	"	4.29
18-3	40.82	29.95	13.70	1.13	1.60	.39	.92	6.38	"	3.33
19-3	53.40	22.70	16.45	1.00	.79	.29	.49	3.25	"	2.61
20-3	57.28	19.45	12.60	.85	.68	.23	.57	3.35	"	2.73
Total Average	56.08	26.39	5.56	1.11	.55	.42	.49	4.49		3.21

Footage covered 4' to 33' and 105' to 175'.

Hole No. 4

2-4	58.24	17.70	15.50	1.20	0.65	2.18	0.18	1.95	0.17	1.48
3-4	62.86	28.20	1.02	1.22	.33	.49	.30	2.82	Trace	2.08
4-4	65.14	26.95	4.11	1.08	.29	.35	.13	.86	"	1.29
5-4	66.60	24.90	2.29	0.98	.31	.22	.21	1.87	"	2.10
16-4	73.50	19.40	1.23	.95	.17	.32	.43	2.35	"	2.26
17-4	67.50	25.80	2.09	.92	.19	.41	.59	2.52	"	1.95
18-4	52.42	42.65	.57	.78	.06	.03	.13	.78	"	2.63
19-4	53.86	38.05	.93	.78	.03	.09	.18	1.43	"	2.56
20-4	59.42	34.55	.61	.44	.39	.05	.16	.50	"	2.18
21-4	63.46	24.85	2.46	.86	.12	.28	.15	.33	"	.81
Total Average	62.30	28.31	3.08	.92	.25	.44	.25	1.54		1.93

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Footage covered 10' to 48' and 105' to 160'

Hole No. 5

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
1-5	48.70	31.65	4.20	1.02	1.14	0.96	1.85	8.30	Trace	4.37
3-5	48.42	32.75	3.35	.91	.16	.87	1.65	8.35	.01	4.75
4-5	49.82	45.15	.76	.75	.06	.03	.19	.85	Trace	2.81
5-5	56.78	38.05	.98	1.20	.03	.02	.19	.71	"	1.72
5-5-A	61.90	31.65	.76	2.45	.02	.02	.06	.10	"	2.11
5-5-B	60.22	34.65	.89	1.62	.02	.01	.14	.47	"	1.80
5-5-C	53.42	41.00	.69	1.20	.03	.01	.15	.44	"	1.97
5-5-D	70.46	24.45	.70	1.95	.03	.02	.04	.09	"	.78
5-5-E	63.80	33.20	.92	1.38	.04	.03	.08	.18	"	1.32
5-5-F	62.92	33.90	.81	1.43	.06	.03	.23	.88	"	1.79
7-5	65.88	25.70	1.14	3.15	.04	.05	.13	.65	"	1.38
8-5	72.28	18.60	2.17	4.00	.05	.06	.09	.37	.02	1.04
9-5	72.54	22.95	.92	1.68	.02	.02	.04	.15	Trace	.90
10-5	69.24	22.45	3.02	1.32	.04	.09	.24	1.10	"	2.38
11-5	50.08	34.40	1.53	1.34	.03	.19	1.38	7.00	"	3.93
12-5	76.90	14.80	.98	4.30	.02	.06	.08	.37	"	.82
13-5	69.34	18.04	2.50	1.45	1.72	.36	.45	2.64	.15	2.66
14-5	76.54	17.50	.86	1.34	.09	.04	.21	1.18	.01	1.03
21-5	48.74	33.85	1.58	.84	.10	.64	1.20	9.50	.01	4.05
22-5	53.50	31.80	1.40	1.08	.14	.27	.97	8.90	.01	3.78
23-5	47.04	31.20	1.72	.86	.46	.53	1.33	11.50	.08	4.43
24-5	51.06	25.00	8.50	1.17	1.85	1.40	.97	5.62	.34	4.36
25-5	52.40	16.40	9.20	1.85	6.70	3.40	1.18	2.60	.04	7.57
26-5	47.62	27.25	6.65	.93	1.95	.89	1.17	8.35	.04	4.59
27-5	52.80	24.35	7.40	.93	1.98	.92	1.38	7.45	Trace	4.09
27-5-A	55.00	38.90	.65	1.32	.05	.03	.08	.75	.05	1.84
28-5	60.34	22.05	5.80	.81	1.85	.78	1.20	4.55	.17	3.20
29-5	64.42	17.45	7.05	.62	3.50	1.00	3.30	2.20	.17	1.97
30-5	57.68	15.80	18.04	1.80	6.15	2.55	1.13	2.35	.22	4.01
31-5	51.86	15.10	16.20	2.12	3.65	3.25	.82	2.50	.24	6.21
32-5	54.88	17.50	15.75	1.22	2.10	2.70	1.08	2.18	.24	3.25
Total										
Average	58.59	27.02	4.12	1.51	1.09	.68	.73	3.29		2.92

Note: Analyses for samples 25-4 and 26-4 are not listed above, but the alumina content as given in the September 30th report by Pittsburg Testing Laboratory indicates that the above hole bottomed in ore.

Footage covered 5' to 117' and 155' to 250'

Hole No. 6

2-6	53.10	33.40	1.70	0.57	0.05	.06	0.47	4.70	0.01	3.43
3-6	56.95	20.90	16.05	1.09	.37	.10	.43	2.05	Trace	1.70
4-6	45.44	39.95	1.45	.70	.05	.05	.89	5.85	"	3.73
4-6-A	57.08	31.50	2.38	.89	.10	.12	.46	2.90	"	2.66
5-6	56.80	33.75	1.22	1.02	.06	.07	.44	2.85	"	2.47
6-6	53.50	32.70	0.70	1.04	.15	.08	1.12	6.05	"	3.65
7-6	71.06	19.80	3.05	.25	.11	.57	.91	2.70	"	2.48
9-6	56.98	33.35	.69	.62	.10	.07	.36	3.30	"	2.53
10-6	63.80	31.40	.79	1.15	.08	.02	.09	.43	"	1.80
11-6	61.30	32.65	1.00	1.03	.06	.02	.21	.89	"	1.74
12-6	59.70	34.80	1.12	.82	.05	.02	.27	1.45	"	1.97
13-6	59.46	30.95	3.85	.91	.08	.24	.32	1.40	"	1.92
14-6	61.04	34.35	.95	.94	.09	.06	.21	1.08	"	1.76
15-6	62.66	33.95	.92	.94	.06	.04	.06	.22	"	1.61
16-6	62.82	32.70	.72	.66	.06	.02	.04	.18	"	1.94
17-6	61.88	34.75	.90	.94	.12	.01	.05	.12	"	2.20
18-6	64.94	29.80	.71	.86	.05	.02	.03	.09	"	1.72
19-6	64.30	31.60	.67	.82	.04	.02	.04	.13	"	1.15
20-6	56.64	37.65	.60	.75	.07	.02	.05	.24	"	2.20
21-6	60.24	32.70	1.52	.74	.05	.02	.21	.94	"	1.98
22-6	62.42	26.90	5.05	.74	.13	.05	.35	1.19	"	1.59

Hole No. 6 (Cont'd.)

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
23-6	54.98	25.65	8.10	.89	.21	.04	.74	3.85	Trace	3.80
24-6	59.58	23.75	4.90	.42	.44	.69	.98	4.45	"	3.10
25-6	63.30	18.10	6.75	.64	2.65	1.11	3.25	1.20	"	2.06
26-6	64.40	18.85	7.10	.70	.34	.80	.61	2.62	"	2.80
27-6	53.70	19.80	16.55	1.03	.47	.22	.63	3.55	"	2.39
28-6	51.82	29.35	6.50	.78	.78	.19	1.05	6.05	"	3.67
Average	58.87	29.82	3.64	.80	.25	.17	.55	2.28		2.46

Footage covered 4' to 229'

Hole No. 7

5-7	61.40	20.40	5.85	0.72	0.61	0.67	1.60	4.90	.03	3.48
6-7	53.92	25.60	2.55	.78	.13	.23	.74	9.30	Trace	4.40
7-7	45.88	34.45	7.50	1.00	.80	.50	.51	5.20	.01	3.27
8-7	56.04	19.90	17.55	.91	.38	.91	.20	1.45	.04	1.53
9-7	53.60	17.80	20.50	1.07	.56	.82	.33	3.00	.06	2.03
10-7	55.06	17.70	16.80	1.02	.49	1.21	.30	3.00	.06	2.64
11-7	54.70	20.20	15.55	.97	.39	.64	.33	3.15	.02	2.68
12-7	57.42	23.95	8.50	.83	.22	.19	.50	4.40	Trace	2.73
13-7	53.12	26.15	9.70	.90	.37	.33	.74	6.80	"	3.22
14-7	63.10	20.30	11.22	.90	.15	.53	.30	2.90	"	2.32
15-7	53.18	30.45	2.40	.78	.10	.20	.56	9.10	"	3.94
16-7	56.46	21.05	14.50	.92	.47	1.21	.33	3.05	.04	3.82
18-7	59.04	26.80	4.25	.53	.09	.46	.67	6.10	Trace	3.90
21-7	62.12	24.60	5.20	.74	.17	.47	.63	4.45	.02	3.13
22-7	59.92	23.95	4.75	.87	.16	.28	.39	4.40	Trace	2.98
24-7	57.10	19.45	16.25	1.02	.51	.74	.39	3.45	.02	2.52
25-7	53.00	24.10	13.70	.98	.49	.36	.64	4.30	.01	2.70
26-7	52.02	23.40	14.50	1.07	.78	.23	.73	5.65	.01	3.08
27-7	43.32	33.40	7.70	.54	.48	.18	1.15	9.30	Trace	2.10
28-7	56.48	21.45	10.85	.98	.41	.43	.53	4.30	"	2.91
Average	54.84	23.75	10.49	.87	.38	.53	.55	4.92		2.97

BISMARK MINE

Hole No. 1 - Footage covered 10' to 130'

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
B-2-1	61.80	20.35	9.30	0.96	0.30	0.89	0.15	2.60	.07	1.80
B-3-1	59.22	21.65	9.20	.91	.20	.71	.33	4.40	.02	2.42
B-4-1	61.56	24.85	3.95	.60	.16	.08	.39	4.40	.01	2.49
B-5-1	64.06	25.10	5.20	1.00	.20	.11	.28	2.85	Trace	2.03
B-6-1	69.86	22.55	3.35	.64	.07	.03	.18	1.22	"	.99
B-7-1	70.80	23.50	2.00	.93	.03	.02	.12	.86	"	1.01
B-8-1	60.64	32.65	1.95	.98	.06	.02	.12	.70	"	1.07
B-9-1	67.22	29.55	.79	.92	.02	.02	.05	.15	"	.97
B-11-1	76.26	21.45	.88	1.27	.02	.02	.04	.42	"	.77
B-13-1	71.14	25.40	.54	1.08	.09	.02	.05	.58	"	.88
B-15-1	69.28	25.55	.60	1.03	.04	.02	.09	.78	"	2.38
B-16-1	73.84	15.95	2.62	.77	.25	.51	.77	2.90	.03	.54
B-17-1	68.28	20.90	3.25	.23	1.25	.68	2.55	3.45	.15	.52
B-19-1	67.56	21.85	1.98	.97	.15	.12	.35	5.25	Trace	1.94
B-20-1	68.44	26.40	1.08	1.05	.03	.02	.07	.70	"	2.38
B-21-1	67.20	24.30	3.45	.80	.05	.01	.08	.67	"	1.77
B-22-1	67.02	25.10	4.20	1.10	.06	.03	.17	1.55	"	1.81
B-23-1	51.42	19.45	11.90	.91	.35	.78	.30	4.10	.05	2.29
Average	65.86	23.65	3.74	.89	.19	.22	.34	2.03		1.55

Hole No. 2 - Footage covered 25' to 56' and 110' to 174'

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
B-3-2	69.40	16.80	4.95	0.18	0.77	0.56	0.80	3.35	.13	1.13
B-4-2	62.52	28.45	5.29	.68	.26	.52	.28	1.67	Trace	.36
B-5-2	69.52	21.00	3.15	1.09	.32	.63	.27	2.50	"	.21
B-7-2	67.88	16.60	3.08	.78	.31	.70	.38	6.50	"	2.02
B-15-2	72.56	23.95	1.03	.69	.20	.35	.13	.17	"	.97
B-16-2	69.52	25.45	1.09	1.23	.23	.38	.07	.15	"	.97
B-17-2	72.74	21.35	1.63	1.10	.31	.38	.22	.13	"	.95
B-18-2	74.00	22.85	1.95	.78	.32	.39	.14	.05	"	1.12
B-19-2	65.22	28.15	1.77	.78	.27	.32	.14	.40	"	1.54
B-20-2	66.36	26.90	2.84	1.29	.32	.41	.20	1.27	"	1.72
B-21-2	69.14	22.05	2.23	.98	.25	.37	.22	1.45	"	2.69
B-22-2	72.46	18.05	3.18	1.12	.36	.46	.20	1.40	"	2.25
Average	69.19	22.63	2.70	.89	.33	.54	.29	1.58		1.33

Hole No. 3 - Footage covered 60' to 171'

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
B-8-3	65.50	22.05	4.15	.93	.04	.46	.25	3.80	Trace	2.11
B-9-3	62.68	22.65	6.30	.85	.07	.37	.31	4.45	.03	1.41
B-10-3	58.36	20.85	11.20	.88	.29	.36	.38	5.30	.04	1.48
B-11-3	56.62	22.85	8.80	.90	.22	.30	.32	5.50	.02	2.64
B-12-3	57.62	18.45	12.20	.88	.33	2.65	.22	3.15	.08	2.84
B-14-3	61.26	20.80	6.90	1.12	.28	1.18	.26	4.90	.12	1.63
B-15-3	57.16	19.30	9.75	.85	4.90	2.40	.19	2.95	.28	1.68
B-16-3	66.34	17.80	6.30	.61	3.45	1.43	.69	2.80	.21	1.31
B-18-3	71.90	13.85	2.57	.32	2.05	.62	.75	3.25	.09	2.73
B-19-3	71.46	14.25	2.57	.58	1.70	.59	.53	2.95	.08	4.09
B-20-3A	62.20	25.25	3.90	1.32	.37	.69	.26	2.15	.02	2.69
B-21-3	49.68	17.05	10.40	1.40	8.10	2.10	3.05	2.18	.11	7.58
Average	61.73	19.59	7.08	.88	1.96	1.09	.60	3.61		2.68

Hole No. 4 - Footage covered 6' to 200'.

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
B-1-4	68.72	25.65	1.48	0.97	0.06	0.05	0.06	0.60	Trace	1.06
B-2-4	67.64	25.95	1.12	0.89	0.06	0.04	0.07	0.81	"	1.78
B-3-4	57.50	31.65	2.80	.65	.24	.53	.23	2.27	.01	2.67
B-4-4	70.62	23.85	1.72	1.00	.04	.06	.08	.74	Trace	1.50
B-5-4	68.62	22.70	4.80	1.15	.06	.04	.10	1.03	.02	1.71
B-6-4	71.68	20.65	2.95	.82	.04	.08	.15	1.75	.01	2.03
B-7-4	55.36	17.95	15.60	.97	.47	2.25	.20	2.65	.20	2.38
B-8-4	59.68	26.15	3.30	.65	.23	.58	.33	4.05	Trace	3.42
B-9-4	61.32	21.80	5.30	.94	.22	.48	.31	4.85	.01	3.66
B-10-4	64.22	21.65	3.35	.86	.32	.13	.31	4.85	Trace	3.60
B-11-4	71.18	15.35	4.75	.40	1.70	.81	2.75	2.55	.13	1.51
B-12-4	72.50	13.95	2.85	.16	2.05	.72	2.60	2.20	.12	.83
B-13-4	71.74	13.10	3.45	.16	3.55	.73	2.65	2.38	.18	.47
B-15-4	61.04	15.40	8.40	.83	5.95	1.85	1.73	2.37	.30	.81
B-16-4	67.12	12.75	6.75	.45	5.00	1.37	3.30	1.75	.25	.57
B-17-4	65.22	15.55	5.85	.58	4.05	1.40	1.65	2.35	.26	1.27
B-18-4	67.00	14.95	8.60	1.06	.59	.95	.32	3.50	.03	2.19
B-19-4	54.56	14.05	17.00	1.08	.85	4.25	.26	2.55	.27	4.41

Hole No. 4 - (Cont'd.)

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
B-20-4	53.96	13.20	16.50	1.22	.83	4.30	.31	3.10	.26	3.83
B-22	51.52	15.50	17.90	1.11	.45	4.55	.17	2.15	.25	4.66
B-23-4	54.16	16.70	15.95	1.06	1.11	4.35	.20	2.40	.29	1.87
B-24-4	51.90	16.50	18.50	1.12	1.50	4.75	.22	1.75	.33	2.28
B-25-4	49.34	25.70	12.50	1.02	1.41	5.00	.16	1.90	.35	2.17
B-26	55.86	17.20	13.30	.94	1.21	4.75	.16	1.95	.32	2.46
Average	62.18	19.08	8.11	.83	1.33	1.83	.76	2.35		2.91

Hole No. 5 - Footage covered 100' to 1718.

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO_2	Ign. Loss
B-1-5	64.44	25.30	0.60	.83	.24	.27	0.20	3.30	Trace	3.06
B-6-5	66.86	27.90	0.36	.38	.04	.03	.10	1.30	"	.99
B-8-5	64.98	25.60	2.12	.88	.04	.05	.19	1.95	"	2.90
B-15-5	77.56	13.53	3.30	.90	.01	.08	.13	1.40	"	1.15
B-16-5	63.96	22.50	9.40	1.52	.02	.05	.15	1.02	"	1.07
B-17-5	61.16	32.95	1.13	1.07	.01	.02	.09	.88	"	1.09
B-18-5	80.44	15.05	.82	1.10	.01	.02	.01	.29	"	.63
B-19-5	84.22	13.55	.47	1.10	.01	.02	.06	.72	"	1.19
B-20-5	70.34	20.95	.73	.83	.01	.01	.17	2.30	"	2.74
Average	71.08	21.90	1.95	.95	.04	.05	.11	1.39		1.57

Each sample represents one-half of the split core length and vary in length from a few feet to 10 feet. The entire length of the drill cores is given after each hole listing.

MINE	HOLE NO.	SAMPLE NO.	FEET FROM	FEET TO
Green Talc	1	1-1	21	27
" "	"	2-1	27	34
" "	1	3-1	34	39
" "	"	4-1	39	45
" "	"	5-1	45	55
" "	"	6-1	55	65
" "	"	7-1	65	70
" "	"	8-1	70	80
" "	"	9-1	80	90
" "	"	10-1	90	95
" "	"	11-1	95	105
" "	"	12-1	105	115
" "	"	13-1	115	125
" "	"	14-1	125	135
" "	"	15-1	135	140
" "	"	16-1	140	150
" "	"	17-1	150	155
" "	"	No Core	155	160
" "	"	18-1	160	170
" "	"	19-1	170	178
" "	"	20-1	178	185
" "	"	21-1	185	200
" "	"	22-1	200	208
" "	2	1-2	15	20
" "	"	2-2	20	26
" "	"	3-2	26	35
" "	"	4-2	35	40
" "	"	5-2	40	45
" "	"	6-2	45	50
" "	"	7-2	50	55
" "	"	8-2	55	57

FINAL REPORT DOCKET NO. 2512 - CONTRACT IDM-2457

MINE	HOLE NO.	SAMPLE NO.	FEET FROM	FEET TO
Green Talc	2	9-2	67	75
" "	"	10-2	75	80
" "	"	11-2	80	88
" "	"	12-2	88	91
" "	"	13-2	91	97
" "	"	14-2	97	106
" "	"	15-2	106	107
" "	"	16-2	107	117
" "	"	17-2	117	130
" "	"	18-2	130	135
" "	"	19-2	135	144
" "	"	20-2	144	145
" "	"	21-2	145	146
" "	"	22-2	146	151
" "	"	23-2	151	156
" "	"	24-2	156	164
" "	"	25-2	164	170
" "	"	26-2	172	180
" "	"	27-2	180	183
" "	"	28-2	183	187
" "	"	29-2	187	197'6"
" "	"	30-2	197'6"	205
" "	"	31-2	205	213
" "	"	32-2	213	221
" "	"	33-2	221	230
" "	"	34-2	230	237
" "	"	35-2	237	240
" "	"	36-2	240	250
" "	"	37-2	250	251
" "	"	38-2	251	255
" "	"	39-2	255	257
" "	"	40-2	257	263
" "	"	41-2	263	264
" "	"	42-2	264	270
" "	"	43-2	270	280
" "	"	44-2	280	282
" "	"	45-2	282	285
" "	3	1-3	1	4'6"
" "	"	2-3	4'6"	16
" "	"	3-3	16	25
" "	"	4-3	25	33
" "	"	5-3	33	41
" "	"	6-3	41	47
" "	"	7-3	47	56
" "	"	8-3	56	66
" "	"	9-3	66	70
" "	"	No Core	70	75
" "	"	10-3	75	90
" "	"	11-3	90	97
" "	"	12-3	97	105
" "	"	13-3	105	115
" "	"	14-3	115	125
" "	"	15-3	125	138
" "	"	16-3	138	148
" "	"	17-3	148	150'6"
" "	"	18-3	150'6"	163
" "	"	19-3	163'	175
" "	"	20-3	175	180
" "	"	20-3	180	190
" "	"	21-3	190	200
" "	4	1-4	3	10
" "	"	2-4	10	20
" "	"	3-4	20	30

FINAL REPORT DOCKET NO. 2512 - CONTRACT IDM-K457

MINE	HOLE NO.	SAMPLE NO.	FEET FROM	FEET TO
Green Talc	4	4-4	30	40
" "	"	5-4	40	48
" "	"	6-4	48	52
" "	"	7-4	52	55
" "	"	8-4	55	60
" "	"	9-4	60	65
" "	"	10-4	65	72
" "	"	11-4	72	76
" "	"	12-4	76	80
" "	"	13-4	80	90
" "	"	14-4	90	100
" "	"	15-4	100	105
" "	"	No Core	105	110
" "	"	16-4	110	115
" "	"	17-4	115	125
" "	"	18-4	125	135
" "	"	19-4	135	145
" "	"	20-4	145	150
" "	"	21-4	150	160
" "	"	22-4	160	170
" "	"	23-4	170	175
" "	"	24-4	175	185
" "	"	25-4	185	195
" "	"	26-4	195	200
" "	5	1-5	5'	6'6"
" "	"	2-5	6'6"	7
" "	"	3-5	7	14
" "	"	4-5	14	20
" "	"	5-5	20	25
" "	"	5-5-A	25	30
" "	"	5-5-B	30	32
" "	"	5-5-C	32	35
" "	"	5-5-D	35	40
" "	"	5-5-E	40	45
" "	"	5-5-F	45	49
" "	"	5-5-G	49	51
" "	"	6-5	51	55
" "	"	7-5	55	64
" "	"	8-5	64	69
" "	"	9-5	69	73
" "	"	10-5	73	83
" "	"	11-5	83	88
" "	"	12-5	88	98
" "	"	13-5	98	108
" "	"	14-5	108	117
" "	"	15-5	117	122
" "	"	16-5	124	127
" "	"	17-5	127	134
" "	"	18-5	134	144
" "	"	19-5	144	154
" "	"	20-5	154	155
" "	"	21-5	155	159
" "	"	22-5	159	162
" "	"	23-5	162	169
" "	"	24-5	169	179
" "	"	25-5	179	189
" "	"	26-5	189	194
" "	"	27-5	194	197
" "	"	"	197	200
" "	"	28-5	200	210
" "	"	29-5	210	220
" "	"	No Core	220	225
" "	"	30-5	225	235
" "	"	31-5	235	240
" "	"	32-5	240	250

FINAL REPORT DOCKET NO. 2512 - CONTRACT IDM-E457

MINE	HOLE NO.	SAMPLE NO.	FEET FROM	FEET TO
Green Talc	6	1-6	0	8
" "	"	2-6	8	18
" "	"	3-6	18	28
" "	"	4-6	28	33
" "	"	4-6-A	33	35
" "	"	5-6	35	43
" "	"	6-6	43	44.5
" "	"	7-6	44.5	54
" "	"	8-6	54	60
" "	"	9-6	60	70
" "	"	10-6	70	80
" "	"	11-6	80	91
" "	"	12-6	91	97
" "	"	13-6	97	107
" "	"	14-6	107	114
" "	"	15-6	114	120
" "	"	16-6	120	130
" "	"	17-6	130	136
" "	"	18-6	136	146
" "	"	19-6	146	147
" "	"	20-6	147	154
" "	"	21-6	154	164
" "	"	22-6	164	174
" "	"	23-6	174	185
" "	"	24-6	185	195
" "	"	25-6	195	205
" "	"	26-6	205	215
" "	"	27-6	215	227
" "	"	28-6	227.5	229
" "	"	29-6	229	236
" "	"	30-6	236	243
" "	7	1-7	0	10
" "	"	2-7	10	20
" "	"	3-7	20	30
" "	"	4-7	30	40
" "	"	5-7	40	50
" "	"	6-7	50	55
" "	"	7-7	55	62
" "	"	8-7	62	65
" "	"	9-7	65	75
" "	"	10-7	75	80
" "	"	11-7	80	90
" "	"	12-7	90	95
" "	"	13-7	95	105
" "	"	14-7	105	107
" "	"	15-7	107	113
" "	"	16-7	113	120
" "	"	17-7	120	126
" "	"	18-7	126	130
" "	"	19-7	130	135
" "	"	20-7	135	145
" "	"	21-7	145	156
" "	"	22-7	156	166
" "	"	23-7	166	175
" "	"	24-7	175	185
" "	"	25-7	185	190
" "	"	26-7	190	204
" "	"	27-7	204	205
" "	"	28-7	205	213

FINAL REPORT DOCKET NO. 2512 - CONTRACT IDM-8457

MINE	HOLE NO.	SAMPLE NO.	FEET FROM	FEET TO
Bismark	1	B-1-1	0	10
"	"	B-2-1	10	15
"	"	B-3-1	15	18
"	"	B-4-1	18	20
"	"	B-5-1	20	26
"	"	B-6-1	26	31
"	"	B-7-1	31	32
"	"	B-8-1	32	38
"	"	B-9-1	38	43
"	"	B-10-1	43	48
"	"	B-11-1	48	52
"	"	B-12-1	52	57
"	"	B-13-1	57	64
"	"	B-14-1	64	67
"	"	B-15-1	67	74.5
"	"	B-16-1	74.5	80
"	"	B-17-1	80	90
"	"	B-18-1	90	100
"	"	B-19-1	100	104
"	"	B-20-1	104	110
"	"	B-21-1	110	115
"	"	B-22-1	115	120
"	"	B-23-1	120	130
"	"	B-24-1	130	135
"	"	B-25-1	135	145
"	"	B-26-1	145	150
"	2	B-1-2	0	15
"	"	B-2-2	15	25
"	"	B-3-2	25	32
"	"	B-4-2	32	35
"	"	B-5-2	35	42
"	"	B-6-2	42	48
"	"	B-7-2	48	56
"	"	B-8-2	56	65
"	"	B-9-2	65	75
"	"	B-10-2	75	85
"	"	B-11-2	85	90
"	"	B-12-2	90	96
"	"	B-13-2	96	106
"	"	B-14-2	106	110
"	"	B-15-2	110	116
"	"	B-16-2	116	125
"	"	B-17-2	125	135
"	"	B-18-2	135	145
"	"	B-19-2	145	155
"	"	B-20-2	155	160
"	"	B-21-2	160	166
"	"	B-22-2	166	174
"	"	B-23-2	174	181
"	"	B-24-2	181	191
"	"	B-25-2	191	200
"	3	B-1-3	2	10
"	"	B-2-3	10	20
"	"	B-3-3	20	23
"	"	B-4-3	23	32
"	"	B-5-3	32	41
"	"	B-6-3	41	50
"	"	B-7-3	50	60
"	"	B-8-3	60	65
"	"	B-9-3	65	70
"	"	B-10-3	70	75
"	"	B-11-3	75	81

MINE	HOLE NO.	SAMPLE NO.	FEET FROM	FEET TO
Bismark	3	B-12-3	81	86
"	"	B-13-3	86	95
"	"	B-14-3	95	102
"	"	B-15-3	102	111
"	"	B-16-3	111	116
"	"	B-18-3	116	121
"	"	B-17-3	121	131
"	"	B-18-3	131	141
"	"	B-19-3	141	151
"	"	B-20-3	151	161
"	"	B-21-3	161	171
"	4	B-1-4	6	16
"	"	B-2-4	16	26
"	"	B-3-4	26	30
"	"	B-4-4	30	35
"	"	B-5-4	35	37
"	"	B-6-4	37	43
"	"	B-7-4	43	51
"	"	B-8-4	51	54
"	"	B-9-4	54	61
"	"	B-10-4	61	69
"	"	B-11-4	69	80
"	"	B-12-4	80	86
"	"	B-13-4	86	96
"	"	B-14-4	96	107
"	"	B-15-4	107	114
"	"	B-16-4	114	120
"	"	B-17-4	120	127
"	"	B-18-4	127	134
"	"	B-19-4	134	139
"	"	B-20-4	139	145
"	"	B-21-4	145	150
"	"	B-22-4	150	160
"	"	B-23-4	160	170
"	"	B-24-4	170	180
"	"	B-25-4	180	190
"	"	B-26-5	190	200
"	5	B-1-5	3	11
"	"	B-2-5	11	16
"	"	B-3-5	16	21
"	"	B-4-5	21	26
"	"	B-5-5	26	28.5
"	"	B-6-5	28.5	35
"	"	B-7-5	35	45
"	"	B-8-5	45	55
"	"	B-9-5	55	61
"	"	B-10-5	61	71
"	"	B-11-5	71	81
"	"	B-12-5	81	91
"	"	B-13-5	91	100
"	"	B-14-5	100	108
"	"	B-15-5	108	114
"	"	B-16-5	114	116
"	"	B-17-5	116	124
"	"	B-18-5	124	132
"	"	B-19-5	132	142
"	"	B-20-5	142	151
"	"	B-21-5	151	161
"	"	B-22-5	161	171
"	"	B-23-5	171	179

It should be pointed out that the various impurities listed in the above analysis are combined as magnetic minerals or as micas which may be readily removed by modern mineral dressing methods.

PYROMETRIC CONE EQUIVALENTS
of DRILL CORE COMPOSITE
SAMPLES

Composite No.	Average Assay			
	SiO_2	Al_2O_3	Impurities Average	P.C.E.
Green Talc Mine				
1-1-Comp.	56.1	27.3	16.6	16
2-1-Comp.	54.9	30.3	14.8	17
3-1-Comp.	54.3	26.9	18.8	18
4-1-Comp.	57.1	27.9	15.0	18
1-2-Comp.	59.4	23.4	17.2	16
2-2-Comp.	53.6	29.3	17.1	19
3-2-Comp.	54.0	26.6	19.4	20
4-2-Comp.	54.9	28.5	16.6	19
1-3-Comp.	61.3	23.5	15.2	19
2-3-Comp.	52.1	31.4	16.5	17
1-4-Comp.	63.2	24.5	12.3	18
2-4-Comp.	57.3	35.0	8.0	20
1-5-Comp.	53.1	35.9	11.0	28
2-5-Comp.	60.2	33.5	6.3	29
3-5-Comp.	60.6	24.8	14.6	19
4-5-Comp.	60.2	25.3	14.5	20
5-5-Comp.	50.2	24.5	26.3	18
6-5-Comp.	57.8	17.6	24.6	19
1-6-Comp.	53.9	31.9	14.2	23
2-6-Comp.	61.3	29.3	9.7	20
3-6-Comp.	60.1	33.4	6.6	28
4-6-Comp.	63.5	32.2	4.3	31
5-6-Comp.	55.5	29.9	14.6	20
1-7-Comp.	52.9	27.7	19.4	15
2-7-Comp.	56.3	23.6	20.1	15
3-7-Comp.	60.3	25.1	14.6	19
4-7-Comp.	52.4	24.2	23.4	17
3-4- P	52.4	42.7	4.9	33
7-5- P	49.8	45.2	5.0	33
6-6- P	56.6	37.7	5.7	32
Bismark Mine				
1-1-Comp-B	62.3	18.9	8.8	15
2-1-Comp-B	62.6	23.5	13.9	15
3-1-Comp-B	70.9	25.5	3.6	23
4-1-Comp-B	69.9	19.6	10.8	16
5-1-Comp-B	67.5	25.2	7.3	17
1-2-Comp-B	66.6	22.1	11.3	18
2-2-Comp-B	72.2	23.6	4.2	20
3-2-Comp-B	68.0	23.9	8.1	19
1-3-Comp-B	60.8	22.1	17.1	16
2-3-Comp-B	62.5	16.4	21.1	18
3-3-Comp-B	64.9	19.7	15.4	16
1-4-Comp-B	66.6	26.0	7.4	18
2-4-Comp-B	62.5	21.7	15.8	17
3-4-Comp-B	68.7	14.1	27.2	16
4-4-Comp-B	58.3	14.9	26.8	15
5-4-Comp-B	52.8	16.2	31.0	15
1-5-Comp-B	70.9	21.5	5.6	23
2-5-Comp-B	72.0	21.0	7.0	23
6-4-P-B				37-8
4-2-P-B				38

ORE RESERVES

The accompanying maps and cross sections of the various diamond drill holes show the areas of influence and the ore blocks. The following summary of ore reserves illustrates the positive and probable tonnage. The probable ore was calculated on the basis that ore would extend 50 feet deeper than the vertical depth of the drill holes.

GREEN TALC MINE

POSITIVE ORE	CUBIC FEET
Block 1	77,000
Block 2	309,000
Block 3	553,500
Block 4	777,000
Block 5	1,654,000
Block 6	3,172,000
Total	6,542,500 cubic feet
Tonnage	575,000

PROBABLE ORE	TONNAGE
Above D. D. Hole #7 . . .	150,000
50 feet below D. D. Holes.	400,000

Total positive and probable ore, 1,125,000 tons

The average weighted alumina content of this ore is 28.6%. This value was calculated on the basis of the areas of influence and the average chemical analysis of the drill holes.

It will be noted that additional samples besides those used in determining ore reserves were included in the ore analyses average which lowered the overall average slightly.

BISMARK MINE

The positive tonnage was calculated by considering the width between the bottoms of No. 2 and No. 4 holes and the depth between surface ore over No. 3 and the bottom of No. 4 holes.

POSITIVE ORE

	Cubic Feet	Tonnage
	756,000	66,000

PROBABLE ORE *

	2,352,000	206,000
Total	3,108,000	272,000 tons

* Probable ore was considered to extend to the depth of No. 4 hole.

The average alumina value was calculated to be 20.5%.

PROSPECTS OF FURTHER ORE DEVELOPMENT

The exploration work recently conducted covered only a small portion of the claim groups. In fact, approximately half of the two claims were explored, whereas 16 other claims

remain. The remaining areas hold very high promise for further ore development as outcrop areas are extensive and the mineralization is very similar to explored areas. A general idea of remaining mineralized areas are shown on claim survey maps. The outcrop areas are very general as no detailed geologic studies have been made.

MINERAL DRESSING TESTS

Although the mineral dressing tests conducted by the Bureau of Mines and reported in W. M. R. 388, are quite incomplete, important data were gathered. Since this work was conducted, other studies have been made by the Bureau and the Coranda Corp. which have shown that considerably more efficient recovery of the alumina values can be made. Perhaps the most important discovery was made when the mineral halloysite was identified which was previously mistaken for sericite. As previously stated, this accounts for the low alkali values in the supposed mineral sericite, whereas the quantities of muscovite found in the ore would account fully for the alkalis present.

As may be easily recognized, the concentration method used and reported in W. M. R. 388, is not adequate for clean and efficient ore separation. This is inherently due to the nature of the ore and the sizing necessary to allow tabling.

Tabling requires rather close sizing of the ground ore, and to attain this end the ore has to be reground and classified several times. During this process the soft minerals, such as halloysite, slimes, and must be removed.

Although recovery of the other aluminum silicates besides andalusite and corundum were not attempted, further work by the Bureau of Mines showed more efficient means for recovering alumina values. This work is covered in an inter-Bureau letter.[1] Two one-ton samples of ore were treated by combination sink float, jigging and tabling methods. Several variations were used, all of which utilized coarse crushing followed by rejection of the gangue by sink-float methods. Various heavy media were used, such as ferrosilicon and galena. With the above methods concentrate varying from 50 to 65% alumina were produced with alumina recoveries ranging up to 60%. If adequate provisions for the recovery of other aluminum silicates had been made, the above method would have realized 80 - 90% efficiency.

Pilot plant sink-float methods of concentrating the ore have been tried and conducted at the Western Machinery Co. of San Francisco. It was found that concentrates of 50 - 60% alumina content could be readily attained with concentration ratios varying between 1.25/1 and 2.5/1, depending on the nature of the ore.

Further concentration of the sink-float concentrates may be performed by cyclonic heavy meadia methods and floatation.

Where magnetic and mica impurities occur in the ore they can be removed by magnetic and air floating systems.

[1] Bureau of Mines Communication, Letter from . . G. Poole to Glen L. Allen, 3/14/45.

THERMAL PROPERTIES OF CONCENTRATES

In evaluating sillimanite minerals for commercial use, one of the most important characteristics is the refractoriness of ore or products. Several tests are used; however, the most

indicative and important are pyrometric cone equivalents and thermal load bearing tests. The P.C.E. values reported for various concentrates in W. M. R. 388 are very high, being considerably above refractories commercially available. These values are listed below.

PYROMETRIC CONE EQUIVALENTS, ANDALUSITE-CORUNDUM CONCENTRATES

Concentrate	Assay, percent Al_2O_3	Assay, percent SiO_2	P. C. E. No.
1	62.6	34.5	37+
2	60.4	37.6	37+
3	60.3	35.9	38-
4	67.6	29.3	38
5	69.2	28.7	39
6	67.1	28.7	40
7	66.3	29.5	38+
8	72.4	25.2	38
9	68.0	30.2	40+
10	65.4	33.6	38
11	65.8	32.3	39+
12	52.1	44.9	35+
13	62.2	35.7	38
14	52.3	44.1	35-
15	59.0	39.6	37.5
16	91.5	5.7	41
Composite	62.3	35.1	38

Further work has been performed on 50% alumina class concentrates, which were made from Bismark ore via Homco sink-float methods. The following table gives the chemical analysis of the two products tested:

Sample No.	L-343-1	L-343-2
Al_2O_3	54.25	56.51
SiO_2	42.12	46.00

These concentrates were of coarse sizing, minus 1/2 inch plus 10 mesh and represent the lower range in alumina content as they were separated at a 2.94 gravity. L-343-1 was characterized as containing corundum and andalusite with associated halloysite and pyrophyllite minerals. L-343-2 was characterized as containing diaspore, pyrophyllite and halloysite.

Samples of each ore were thermally load tested by one of the major refractory company research laboratories according to standard methods.[1] In that Sample L-343-1 was made up of corundum and andalusite, it was considered unnecessary to precalcine the concentrate as material of this sort is volume stable at high temperatures. Diaspore is of higher specific gravity and expands on firing in its conversion to mullite.

The following table illustrates the results of the thermal load tests:

Sample No.	L-343-1*	L-343-2	Arco 70
Point of Incipient[1] Fusion	1410°C	1405°C	1340°C
% Deformation Point of	0.31%	0.30%	0.35%
1% Deformation Point of	1457°C	1460°C	1410°C
4% Deformation Point of	1482°C	1500°C	1485°C
10% Deformation	1492°C	1520°C	

* L-343-1 - Uncalcined corundum and andalusite
L-343-2 - Calcined Diaspore
Arco 70 - General Refractories - 70% alumina brick

[1] 25 psi load applied

The specimens were loaded thermally under compression and in a slightly reducing atmosphere which may give lower failure points.

A comparison of the values found for Arco 70 show that samples L-343-1 and L-343-2 are of exceptional refractoriness.

The following table gives the shrinkage values of the specimens fired at 1500°C.

Sample No.	L-343-1	L-343-2	Arco70	Periclase
%Shrinkage	0.74	0.66	1.8	3.0
Density gm/C.C.	2.38	2.05	-	-
Density #/Cu.ft.	148	128		

The shrinkage values for samples L-343-1 and L-343-2 are very low in comparison with commercial refractories. The high density of the specimens show a relatively low porosity.

The following table shows the P. C. E.[2] values for the above samples.

Sample No.	L-343-1*	L-343-2*	70% Alumina Brick
P.C.E. equivalent	37-38	38	36-37
Temperature °C	1820-1835	1835	1810-1820

*These samples were tested at Pittsburg Testing Laboratories, San Francisco, California.

The above results show and substantiate the data obtained in the above load tests.

Although it is known that alumina ores of the above nature readily convert to the desirable constituent mullite, it is exceptional that bonding strengths and refractoriness of this nature results. It is believed that the presence of corundum in L-343-1, which is unattacked up to 1910°C, plus the bonding influence of assessory minerals account for the high strength.

Supervising Ceramic Engineer

[1]Journal of American Society, Nov, 1941, pg. 348, "An Automatic Apparatus for Testing Refractories Under Tensile and Compressive Loads at High Temperatures", J. A. Scarlet and Dr. J. A. Robertson.

[2]Manual of A.S.T.M. Standards on Refractory Materials, A.S.T.M. C-24-46, pg. 74.

The following tables illustrate pyrometric cone values of composites of drill core samples. These composites were made up to represent the ore reserves. No concentrating of these samples was performed as no provisions were made for concentrating and analyses of concentrates in the contract.

Docket No. DMEA-2512
Contract No. Idm-5457

Green Talc Mine
Mineral County, Nevada

Diamond Drill Log, Hole #1
Strike S 67° 8' E, Dip 20°00'

Feet From	To	Core Size	Description
0	21	NX	Over burden - no core recovery.
21	27	NX	60% C.R. 21' to 25' meta volcanics, dark ground mass.
25	27	"	Ore zone-sericite inclusions.
27	34	"	General ore zone - dark inclusions.
34	39	"	Same as above - ground mass becoming darker.
39	45	"	Lean meta volcanics 50% C.R. Some ore inclusions, becoming more mineralized at 42'.
42	45	"	Ore zone.
45	47	"	Solid ore.
47	50	"	General ore zone, solid.
50	55	BX	Broken up ore zone. Sericite inclusions.
55	60	"	50% C. R. Ore zone.
60	65	"	Solid ore-darker ground mass - good ore.
65	70	"	60% C. R. Good ore zone - black barren seam of meta-andesite 60-70'.
70	71	"	70% C. R. 70-71' ore showing.
71	75	"	Dark ground mass-barren meta volcanics. Possible corundum showing at 74'. 74-75' lean mineralization.
75	76	"	75-76' meta volcanics.
76	82	"	Broken up ore zone. Less mineralization from 80-82.
82	85	"	Ore zone - dark ground mass. More highly mineralized.
85	90	"	80% C. R. Ore zone - more barren from 85 to 90'. Low grade ore at 90'.
90	95	"	General ore zone. Poorly mineralized 94-95'.
95	100	"	Highly broken up zone - meta volcanics. No ore showing.
100	105	"	Meta volcanics, dark ground mass 90% C.R. Material solid.
105	110	"	Same as above - lighter ground mass - considerable shear action or plate like structure. 100% C. R. 70% C. R. Meta volcanics.
115	120	"	115'-117' lighter ground mass-porphrytic structure. 117'-120' Feldspar crystals altered to Kaolin. 70% C. R.
120	125	"	Darker ground mass, meta volcanics 50%. More broken up.
125	130	"	Same as above.
130	135	"	80% C. R. Same as above.
135	140	"	70% C. R. Same as above. Altering at 140' to sericite.
140	145	"	Sericite with Al-Si, black inclusions shown, 20% C.R.
145	150	"	Same as above.
150	155	"	Highly broken sericite zone changing to mud seam.
155	160	AX	No core recovery - changed to AX drill size at 160'.
160	165	"	Ore zone - dark inclusions - highly broken up. 30% C.R.
165	170	"	60% C. R. Light ground mass, sericite, Al-Si showing.
170	175	"	60% C. R. Same as above showing kaolinization.
175	180	"	Sericite-same as above altering to showing of meta volcanics 178-180.
180	185	"	20% C. R. Highly broken up country. Meta volcanics, Occasional Al-Si showing.
185	190	"	20% C. R. Light colored meta volcanics.
190	195	"	Mud seam - 5% C. R.
195	200	"	No core recovery-mud seam.
200	208	"	100% C.R. Dark colored meta volcanics-highly siliceous - scattered sulfides showing. Bottom of hole.

Docket No. DMEA-2512
Contract No. Idm-E457

Green Talc Mine
Mineral County, Nev.

Diamond Drill Log-Hole #2
Strike N. 45o W; dip 25o N.W.

Feet From	Feet To	Core Size	Description
0.0	15.0	NX	No core.
15.0	20.0	"	Occasional quartzite boulders in overburden.
20.0	26.0	BX	Highly brecciated silicified meta-andesite, iron-stained fractures, occasional manganese stain in fractures.
26.0	31.0	"	Dark granular silicified meta-andesite, gradually becoming more silicious, quartz breccia inclusions.
31.0	31.5	"	Small sericite particles in oxidized, brecciated silicified fault stringer.
31.5	37.0	"	Silicified meta-volcanics containing quartz breccia inclusions. Iron-stained fractures at 33 feet. Core becoming unconsolidated, occasional core.
37.0	47.0	"	Schistose structure, sericitized, becoming more massive, occasional sillimanite minerals observed. Hematite streaks and vugs in sericite and quartzite matrix. Hematite making up about 5% of rock mass at 45 to 47'.
47.0	65.0	"	Extremely vuggy quartzite, considered true quartzite, iron stains impregnating material. Occasional area showing pyrite mineralization. No sericite observed; Blue green material in quartz matrix at 53.2 (copper mineralization). Fresh pyrite becoming more pronounced at 60 to 65 feet.
65.0	66.0	"	White bull quartz, epidote filling of fracture.
66.0	67.0	"	Quartzite containing fresh pyrite, oxidized and vuggy in part.
67.0	75.0	"	Brownish fine sand, becoming claylike, epidote in matrix. No core recovered 70-75 feet.
75.0	79.0	"	Soft partially granular, and base material, assuming sandstone appearance. Gradually becoming harder and having appearance of silicified meta-volcanic.
79.0	80.0	"	Broken silicious material, occasional epidote in fractures.
80.0	90.0	"	Micaceous appearing material, very soft becoming harder; could be altered (volcanic like material). Very slightly sericitized at 81 feet.
90.0	107.0	BX	Sericite in quartzite, epidote noted at 91 feet. Core recovery 28% to here. No core from 100 to 105 feet. Sericite in schistose structure at 105 feet, becoming softer, changing to sericite pebbles in soft (kaolinite) matrix.
107.0	117.0	BX	Hard silicious material, pyrite mineralization, no ore.
117.0	130.0	"	Broken sericitic silicified at edge of ore zone. sillimanite minerals quite prominent, poor core recovery. Fault strucute, oxidation, between 128-130 feet.
130-0	135.0	"	Sericite cementing dark gray to black mineralized inclusions (meta-andesite.)
135.0	144.0	"	Kaolinized zone, occasional sericite, containing prominent sillimanite minerals. Dark gray inclusion from 137-139 feet and again at 141-142.5 feet. Remainder very light in color.

Docket No. DMEA-2512
Contract No. Idm-E457

Green Talc Mine
Mineral County, Nev.

Diamond Drill Log - Hole #2
Strike N. 45° W; dip 25° N.W.

Feet From	To	Core Size	Description
144.0	146.0	"	Dark inclusions, believed to be (meta-volcanics) cemented with sericite, becoming more mineralized at 146 feet.
146.0	151.0	"	Predominately sillimanite minerals, fractured and recemented with sericite, highly sheared area 148-150 feet. Good core recovery.
151.0	156.0	"	Light porous, dark grained (altered and decomposed diorite-like), granular appearance, associated with a black (schist)material, contact material noted at 156 feet. No mineralization.
156.0	172.0	"	Predominately (kaolinite) associated with sillimanite minerals, black schist inclusions, becoming progressively darker in color with occasional sericite and andalusite observed, dark (schist) material has crinkly appearance. Believed to be mineralized.
172.0	173.0	"	Schist structure altering to a brecciated mud, some sericite in breccia (possible fault structure).
173.0	180.0	"	White kaolinite material cementing dark schist, crinkly effect. Some mineralization.
180.0	180.5	"	Soft granular purpole zone (meta-andesite). No mineralization.
180.5	187.0	"	Dark schist, sericitization in fracture. Light brown crystals (pyrite casts) altered to hematite, scattered through rock mass.
187.0	190.0	"	Green sericite altered to clay, occasional Al-Si gouge zone.
190.0	195.0	"	Highly broken zone, sericitized, some clay, bull quartz and pyrophyllite noted at 195 feet.
195.0	201.0	"	Less broken, solid core, sericite, becoming cherty towards 200 feet.
201.0	212.0	"	Bands of sericite, somewhat silicified in schistose structure. Solid sericite at 206 feet and at 212 feet.
212.0	215.0	"	Gradual transition from massive sericite to sericite and meta-andesite shcist; schist partly replaced by sericite and monor amounts of Al-Si.
215.0	225.0	"	Silification of meta-andesite.
225.0	230.0	"	Sericite - meta volcanics.
230.0	230.5	"	Darker ground mass broken up. Some sericite.
230.5	233.0	"	Contact, change in structure to finer ground siliceous structure. Sericite. Lighter ground mass increasing mineralization - 233.
233.0	235.0	"	Meta-volcanics, silicified.
235.0	237.0	"	Same as above. Contact changed to definite mineralization (sillimanite minerals (Al-Si).
237.0	240.0	"	Same as above, altering to meta volcanics, sericite.
240.0	245.0	"	Broken up meta volcanics with sericite.
245.0	247.0	"	Meta volcanics with some mineralization and darker ground mass.
247.0	248.0	"	Mineralization changing to meta volcanics.
248.0	250.0	"	Meta volcanics silicified.

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Green Tale Mine
Mineral County, Nev.

Diamond Drill Log - Hole #2
Strike No. 45° W; dip 25° N.W.

Feet From	To	Core Size	Description
250.0	251.0	"	Mineralized zone Al-Si.
251.0	255.0	"	Meta volcanics - some sericite changing from dark to lighter ground mass.
255.0	257.0	"	Alteration to mineralized zone Al-Si.
257.0	260.9	"	Alteration to meta volcanics. Silicified changing to darker ground mass.
260.0	263.0	"	Meta volcanics. Light ground mass with dark inclusions.
263.0	264.0	"	Mineralization Al-Si.
264.0	265.0	"	Meta volcanics.
265.0	270.0	"	Meta volcanics becoming indreasingly mineralized Al-Si.
270.0	275.0	"	Meta volcanics with sericite inclusion. Slight mineralization.
275.0	280.0	"	Same as above becoming more broken up.
280.0	282.0	"	Same as above.
282.0	285.0	"	Mineralization, ground mass becoming more broken up.
285.0	286.0	"	Alteration to dark ground mass, meta volcanic. Bottom of hole.

Diamond Drill Log - Hole #3
Strike N. 49° W; dip 20° N.W.

0	4.5	NX	White (kaolinite)? changing to greenish cast sericite containing sillimanite minerals.
4.5	16.0	BX-5'	Soft mica schist inclusion, occasional gneissoid schist. No mineralization.
16.0	19.0	"	Greenish sericite containing sillimanite mineralization.
19.0	33.0	"	White kaolinite with occasional sericite inclusions. becoming progressively more mineralized at 26 to 33 feet.
33.0	41.0	"	Fine grained quartzite (no contact material) noted. Epidote at 41 feet. No mineralization.
41.0	45.0	"	Soft mud gouge assuming schistose structure, silicified and harder at 45 feet. No mineralization.
45.0	56.0	"	Considered to be quartzite at 45 feet, occasional epidote in fractures, in dark grained silicified meta-andesite, some mottled effect quartz breccia inclusions.
56.0	56.5	"	Black fine-grained dike (unknown width) lamprophyre cutting.
56.5	66.0	"	Mottled silicified meta-andesite, dark, containing occasional epidote fillings in fractures.
66.0	90.0	"	Dark mud gouge, soft sandstone appearance, meta-andesite and altered schist. Little to no core.
90.0	97.0	"	Harder schistose material at 90 feet, very little core, softer material at 95 to 97 feet becoming mud and clay at 97 feet. No mineralization. 26% core recovery to here.
97.0	99.0	"	Fractured flaky sericite, containing quartzite, brecciated and recemented.
99.0	105.0	"	Fractured quartzite, oxidized in fractures, pyrites in fresh rock. No sillimanite minerals.
105.0	115.0	AX	Dark brown quartzite, slightly brecciated, minor amounts of sericite in fractures. Pyrites in fresh rock, oxidized in fractures.

Docket No. DMEA-2512
Contract No. Idm-E457

Green Talc Mine
Mineral County, Nev.

Diamond Drill Log - Hole No. 3
Strike N. 49° W; dip 20° N.W.

Feet From	Feet To	Core Size	Description
115.0	138.0	AX	Sericite, minor amounts of sillimanite minerals, poor core recovery. Rock becoming kaolinized at 130 feet, sericitization of fractures, increasing sillimanite minerals, (corundum).
138.0	148.0	"	Black inclusions (meta-volcanics) cemented with sericite.
148.0	150.5	"	Light green sericitic material sillimanite materials present.
150.5	158.0	"	Dark silicious(meta-volcanic) rock, slightly sericitized in fractures.
158.0	162.0	"	Dark mottled silicious schist, small lamprophyre dike at 159.0 feet. Very small amount of sericite noted. Schist becoming lighter in color to 160.0 feet.
162.0	170.0	AX	Light grey porphyritic schist, no mineralization, good core recovery. Slight sericite seam observed at 168.0 feet.
170.0	195.0	"	Hematite noted at 176.0' and again at 180.0 to 195.0 feet in porphyritic schist. Slightly silicified at 178.0 feet.
195.0	195.0	"	Predominantly light gray porphyritic schist, slightly silicified. No mineralization.
195.0	200.0	"	Black firm grained sand. Very little core. Bottom of hole.

Diamond Drill Log - Hole #4
Strike N 400 W, Dip - 90°

Feet From	Feet To	Core Size	Description
0	3	NX	Overburden
3	5	"	Meta volcanics - dark ground mass. Fine crystal structure, black in color. Dense, dark grained basalt G. C. R.
5	10	"	Same as above G. C. R.
10	15	"	Same except more broken up at 14' - 15' G.C.R.
15	17	"	Lighter ground mass - alteration phase at 17' G. C. R.
17	20	"	Lighter ground mass becoming mineralized at 20' G. C. R.
20	25	"	Becoming highly mineralized at 24' - inclusions of sericite in light ground mass, kaolinite
25	30	NX	Same as above.
30	35	"	Mineralized zone becoming darker in color.
35	40	"	Low grade ore - some pyrite and hematite inclusions - becoming more mineralized. 100% C.R.
40	45	"	Ore zone G.C.R.
45	48	"	Lower grade ore zone.
48	50	"	Becoming siliceous - darker ground mass - hematite inclusions.
50	52	"	Same as above but with purplish cast - suspected mineralization. (sillimanite 50% C.R. broken up.)
52	55	"	Broken up country - silicified inclusions of talc, 50% C. R.
55	60	"	Low grade mineralization, kaolinite structure 50% C. R. conglomeration of ore particles shot through, light ground mass - meta volcanics.

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Contract No. Idm-5457

Green Talc Mine
Mineral County, Nev.

Diamond Drill Log - Hole #4.
Strike N 49° W, Dip - 20°SW

Feet From	To	Core Size	Description
60	65	BX	Broken up country - Iron inclusions at 62' - Hematite, oxidized surface - some mineralization. Contact or change at 64' lighter ground mass - brecciated. 60% C. R.
65	68	BX	66' Meta volcanics - showing mineralization - 68'
68	70	"	Same as above.
70	72	"	Light ground mass, meta volcanics, hematite seams-mineralization. Some kaolinization.
72	75	"	60% C. R. Light colored ground mass - silicified - mineralization, ore zone. Manganese - 74'. Sandstone structure light ground mass.
75	80	"	Quartzite. Broken up. 40% C. R.
80	85	"	10% C. R. Mudseams - intervening. Iron stains - quartzite - purplish cast - through 85' oxidized surfaces.
85	90	"	Same as above.
90	95	"	Same as above. 60% C. R.
95	100	BX	Quartzite showing sulfide - 80% C. R. Oxidized seams.
100	105	"	5% C. R. Broken up quartzite, showing considerable iron oxidation.
105	110	"	No C. R.
110	115	"	10% C. R. Kaolin or talclike material.
115	120	"	Meta volcanics, sericite inclusions showing at 117' becoming increasingly mineralized with sericite. 70% C. R.
120	125	"	Sandy structure altering to meta volcanics, altering to sericite at 123'. 60% C. R. becoming mineralized at 122' - general ore zone.
125	130	"	Ore zone. Al-Si - sericite inclusions.
130	135	"	Same as above.
135	140	"	C. R. 50% Ore zone - corundum seams showing. Good ore.
140	145	"	90% C. R. Good ore zone.
145	150	"	Same as above except darker ground zone.
150	155	"	Al-Si altering to meta volcanics - dark ground mass.
155	160	"	Highly siliceous material changing from dark to light ground mass.
160	165	"	Altered to Al-Si ore zone at 160'. 160-165 ore zone.
165	170	"	Ore zone 100% C. R. altering to meta andesite. Ore zone 100% C. R. Some mineralization.
170	175	"	Same as above.
175	180	"	Meta andesite - highly brecciated light ground mass with dark phenocrysts. 100% C. R.
180	185	"	Same as above - sericite showing 185'. Meta andesite - dark ground mass.
185	190	"	Same as above. 50%. C. R.
190	195	"	Same as above at 195' altering to kaolinized structure. 60% C. R.
195	200	"	Same as above - some mineralization at 197' becoming more broken up. Sericite showing at 198'. Bottom of hole.

Docket No. DMEA- 9519
Contract No. 14m-2457

Green Talc Mine
Mineral County, Nevada

Diamond Drill Log - Hole #6

Strike S 45°00' E, Dip - 30°00'

Feet From	To	Core Size	Description
0	5	NX	Overburden
5'	5'6"	"	Al-Si Minerals-sericite. G. C. R. Becoming broken up.
5'6"	7'	"	Mud gouge - P.C.R.
7'	14'	"	Alteration to ore zone with green sericite inclusion. G. C. R.
14'	20'	"	Ore solid - good quality. General ore zone. G. C. R.
20'	25'	"	Green sericite more predominant. G. C. R. General ore zone.
25'	30'	"	Quality of ore decreasing - ore zone solid. Buff colored material dispersed throughout G.C.R.
30'	40'	"	Same as above. G. C.R.
40'	49'	"	General ore zone becoming quite broken up. Fair C. R.
49'	51'	"37'	Mud gouge - no mineralization. P. C. R. Mud seam.
51'	55	"	Same as above.
55	57'6"	"	White talc-becoming mineralized.
57'6"	64	"	Mineralized ore zone, light buff ground mass G. C. R.
64	69	"	General ore zone broken up at 69'.
69	73	"	Not so fractured at 70'. Becoming broken up at 72'. Light buff ground mass - ore zone.
73	78	"	General ore zone - more sericite inclusions.
78	83	"	78-80' broken up ore zone - mud seam to 83'. Clay and talc G. C. R.
83	88	"	Ore zone - broken up.
88	95	"	Ore zone - less broken up. Light buff ground mass - becoming more quartzitic.
95	100	"	Ore zone - sericite inclusions.
100	106	"	P. C . R. Ore zone - Corundum showing quite strongly
106	110	"	P. C. R. Brecciated ore zone.
110	117	"	50% C. R. General ore zone - Solid
117	122	"	Broken up material ore zone.
122	124	"	Ore zone - solid.
124	127	"	Quartzite-showing scattered pyrite on fresh surface and some oxidation. Alteration at 127' to kaolinization.
127	129	"	General ore zone - not highly mineralized, 80% C.R.
129	132	"	Highly kaolinized-showing Al-Si inclusions. Solid ore.
132	134	"	General ore zone - tending towards kaolinization. Solid ore, 90% C.R.
134	139	"	Ore zone. Well mineralized. Solid ore zone. 60% C.R.
139	144	"	Highly broken up ore zone. Sericite inclusions 50% C. R.
144	149	"	20% C. R. Same as above.
149	154	"	40% C. R. Same as above becoming well kaolinized and altering to quartzite at 154'.
154	155	"	Quartzite, oxidized seams, altering to light green sericite, highly broken up.
155	159	"	Sericite inclusions in dark ground mass. Meta andesite-somewhat broken up altering to Al-Si mineralization.

Docket No. DMEA-2512
Contract No. Idm-2457

Green Talc Mine
Mineral County, Nevada

Diamond Drill Log - Hole #5
Strike S 45°00' E, Dip - 30°00'

Feet From	To	Core Size	Description
159	160	NX-37'	159'-160' solid ore zone-some sericite inclusions, becoming highly broken up. 90% C.R.
160	162	"	Highly broken up ore zone. 90% C. R.
162	164	"	75% C. R. Same as above.
164	168	"	75% C. R. Highly broken up ore zone-meta volcanic inter-mixed.
168	174	"	Solid ore zone-considerable sericite included. 70% C. R. Small amounts meta volcanics in vugs
174	179	"	100% C. R. Highly broken up ore zone-showing shear planes. Some dark masses included.
179	184	"	40% C. R. Same as above.
184	189	"	Crushed zone - some ore showing, sandy structure.
189	194	"	Altered meta volcanics, 80% C. R. Dark olive or mud appearance on wetting. Considerable brecciation. Alteration to low grade ore.
194	197	"	Highly broken up low grade ore zone. 50% C. R. Some meta volcanics showing in pebbles.
197	200	"	10% C. R. Highly broken up ore zone-sericite inclusion and meta volcanics.
200	210	"	Same as above except highly sheared and tending to a schistose structure. 100% C. R.
210	215	"	Highly broken up meta volcanics - dark ground mass.
215	225	"	Same as above except lighter ground mass.
225	230	"	Meta volcanics - highly broken up, very siliceous.
230	235	"	Meta volcanics - highly brecciated - pyrites and oxidized faces.
235	240	"	Same as above.
240	250	"	Same as above.

Diamond Drill Log Hole #6
Strike S 90° 18' E, Dip-30°

0	5	"	Overburden
5	8	"	Quartzite boulder at 5'; broken up condition at 6.5', meta andesites, somewhat brecciated with sericite and Al-Si mineralization. Country highly broken up at 7'. Highly mineralized with sericite and dark inclusions. 100% C. R.
8	10	"	Same as above except kaolinized structure. Becoming more mineralized with Al-Si and corundum. General ore zone 100%.
10	20	"	Ore zone, showing corundum and Alsi, some dark inclusions and sericite. Small seam of meta volcanics at 16-17', 100% C. R., broken up zone at 19', 19.6-20-meta volcanics.
20	25	"	Meta volcanics, dark ground mass, solid structure, broken up seam at 24', small inclusions of sericite.
25	30	"	Meta volcanics, dark ground mass, solid structure to 27'. Broken up zone from 27-29' altering to sericite and Alsi with inclusions of quartzite - 80% C. R.

Docket No. [illegible]
Contract No. I4m-[illegible]

Green Talc Mine
Mineral County, Nevada

Diamond Drill Log Hole #6
Strike S 79°15' E, Dip-90°

Feet From	To	Core Size	Description
20	33	NX-37'	Sericite structure and Al-Si minerals. Mineralization increasing. Small seam of broken up country at 30', 100% C.R. Alteration to meta andesites at 31'. Alteration to Al-Si ore mineralization at 33'
33	37	"	General ore zone with some andesites at 33-35', broken up at 37'-38'. 90% C.R.
37	43	"	90% C.R. General ore zone, broken up 38-41'.
43	49	"	43-44.5 ore zone, highly kaolinized, 44.5' - 48', meta andesite, light ground mass, small specks of manganese, becoming highly broken up and soft at 48', kaolinized.
49	54	"	Kaolinized structure light ground mass, highly broken up, becoming more oxidized P.C.R. 90%.
54	59	"	Highly broken up to 58', seams of hematite and sericite in andesite. Light ground mass 58'-59', 90% C. R.
59	65	"	Meta andesite to 60', alteration to sericite and Al-si. General ore zone.
65	71	"	General ore to 70', altering to more silicious material at 71'. 100% C. R.
71	76	"	Change at 71' to general ore zone. Increasing corundum showing. 100% C. R.
76	81	"	Ore zone becoming more coarsely crystalized. Siliceous in appearance.
81	86	"	Highly broken up andesites, light ground mass to 86', highly oxidized faces. Ground mass changes markedly to dark color, meta volcanics. 90% C. R.
86	90	"	Meta volcanics, dark ground mass. 90% C. R.
90	91	"	Same as above.
91	96	"	Highly broken up ore zone, no apparent change in structure to indicate alteration zone. 92-96' ore zone solid, sericite inclusions. 100% C. R.
96	99	"	96-97' ore, altering to meta volcanics, alternating dark ground mass for few inches, then light ground mass to 99'. 100% C. R.
99	105	"	Meta volcanics-dark ground mass with light patches. 100% C. R.
105	110	"	105-107' same as above altering to sericite mineralization. Highly broken up to 110'. 70% C. R.
110	114	"	Ore zone to 114' where rock is becoming quartzite. 90% C. R.
114	120	"	Broken up at 114', altering to general ore zone, quite siliceous to 120'. 100% C. R.
120	125	"	General ore zone same as above cementing rock more solid. 100% C. R.
125	130	"	General ore zone. 100% C. R.
130	136	"	Same as above. 100% C. R.
136	139	"	Same as above, 100% C. R.
139	146	"	Same as above, alteration at 146 to meta volcanics with Al-si shot through, dark ground mass.
146	150	"	Alteration from meta volcanics at 147' to general ore zone, darker in color. 100% C. R.
150	154	"	Ore zone to 153' where alteration takes place to quartzite with ore shot through to 154'. 100% C. R.

Docket No. DMEA-[illegible]19
Contract No. Iam-[illegible]457

Green Talc Mine
Mineral County, Nevada

Diamond Drill Log Hole #6
Strike S 72°15' E, Dip -[illegible]°

Feet From	To	Core Size	Description
154	161	NX-37'	Quartzite with streaks of Al-Si mineralization to 158'. Ore zone to 161, 80% C. R.
161	164	"	General ore zone, seam of hematite with ore shot through at 163'. 100% C. R.
164	170	"	Alteration to meta volcanics at 164', dark ground mass to 176' where sericite inclusions occur, highly broken up at 171'. 80% C. R.
170	176	"	Meta volcanics with small inclusions of sericite, P.C.R. 10%.
176	179	"	Same as above, P.C.R. 10%.
179	186	"	Alteration to Al-Si and sericite at 186', P.C.R. 90% highly broken up.
186	191	"	Alteration to meta andesites at 186', becoming increasingly darker with phenocrysts becoming frequent. 10% C. R.
191	197	"	Meta volcanics, dark ground mass, highly broken up from 195-197'.
197	201	"	Same as above, faces oxidized, highly broken up, C. C. R. 10%, some sericite inclusions.
201	205	"	Highly siliceous meta volcanics highly broken up, 90% C. R.
205	208	"	Same as above, becoming sandy. P.C.R. 90%.
208	212	"	Meta andesites, lighter ground mass, rock more solid.
212	216	"	Same as above, 80% C.R.
216	221	"	Same as above, 80% C. R.
221	226	"	Same as above, 80% C. R.
226	227.5	"	Same as above, 90% C. R.
227.5	231	"	Alteration at 227.5 to Al-Si continuing to 229 where another alteration occurs, meta andesites with sericite inclusions to 231, 80% C. R.
231	236	"	Changing to darker ground mass at 231, faces show oxidation, continuing to 236.
236	243	"	Same as above. End of hole

Diamond Drill Log - Hole No. 7
Strike S 72°15' E, Dip - 90°

0	4	"	Meta volcanics, light ground mass to 4'.
4	5	"	Black siliceous dike altering back to meta volcanics at 5'. 100% C.R. Highly broken up.
5	20	"	Alternating dark and light ground mass made up of meta volcanics. Mud seam at 15'. 15'-20' meta volcanics. 90% C.R. Highly broken up.
20	30	"	Lighter colored meta volcanic to 25'. 25' to 30' very light ground mass, meta volcanic. 50% C.R. Broken up country. Highly altered.
30	40	"	Meta volcanic, altered; appears somewhat kaolinized. Light ground mass. Highly broken up.
40	45	"	Same as above. 60% C.R. Highly broken up. Highly altered.
45	47	"	Very highly broken up. Same as above. P.C.R.
47	48	"	Rock more solid. Light colored meta volcanic. Small seams of hematite, altering to sericite at 48'. 90% C. R.

Docket No. DMEA-2512
Contract No. Ism-E4b7

Green Tale Mine
Mineral County, Nevada

Diamond Drill Log Hole #7
Strike S 79°15' E, dip-80°

Feet From	Feet To	Core Size	Description
48	50	NX-37'	Same as above, 90%. C. R.
50	55	"	Sericite to 53' where material changes to meta volcanics and continues to 54' where alteration to sericite occurs; back to dark meta volcanics at 55'. 100% C. R.
55	60	"	Dark meta volcanics to 56' changing to light ground mass. 90% C. R.
60	65	"	Lighter colored meta volcanics to 62'. Broken up country for few inches, altering to dark material blue to bluish color. Suspected corundum, 62-64'. 90% C.R. 64-65', dark blue to black. Hematite seams. Suspected corundum. Somewhat siliceous in appearance. 100% C.R.
65	70	"	65-67' same as above, altering to darker meta volcanics. Dark crystals still appearing. 80% C.R.
70	75	"	Alteration to meta volcanics, changing from dark to light ground mass at 74'.
75	80	"	Same as above excepting blue cast which appears to contain corundum. Mineralization. 80% C.R.
80	85	"	Dark meta volcanics changing to lighter ground mass at 83'. 80% C.R.,changing to dark meta volcanics at 84' with considerable mineralization. Highly altered.
85	90	"	Change-merely at 86' to light colored oxidized meta volcanics, highly altered phenocrysts. 70% C.R.
90	95	"	80% C.R. Light colored meta volcanics, somewhat broken up.
95	100	"	100% C.R. Sericite showing at 96' in light meta volcanics which continues to 97'. Oxidized surfaces. Changes to lighter meta volcanics, considerable mineralization. Core solid. Hematite seams at 100'.
100	105	"	100% C.R. Hematite spots and seams in meta volcanics. Light ground mass. Considerable mineralization.
105	110	"	Meta volcanics with bluish cast. Altering to sericite and Al-Si minerals at 107'. General ore zone to 110'. 100% C.R.
110	115	"	100% C.R. Continuing general ore zone to 113' where alteration takes place to light colored meta volcanics which continues to 115'.
115	120	"	Continuing meta volcanics more broken up. Oxidized surfaces. Ground mass changing to dark color at 118'. Continuing meta volcanics to 120'. 80% C. R.
120	125	"	Continuing meta volcanics lighter in color, somewhat broken. Highly broken up at 124'. 80% C.R.
125	130	"	Continuing light colored meta volcanics to 126' where alteration to sericite and Al-Si minerals take place. Continues solid to 128' where country is highly broken up. General ore zone. 80% C.R. Alteration at 130' to porous quartzite, greyish cast.
130	135	"	Continuing porous quartzite to 134' where alteration takes place to light colored meta volcanics. Considerable hematite.

Docket No. DMEA-9519
Contract No. Idm-F4b7

Green Tale Mine
Mineral County, Nevada

Diamond Drilling Log - Hole No. 7
Strike S 79°15' E, Dip 90°

Feet From	Feet To	Core Size	Description
135	140	NX-37	Continuing meta volcanics. Changing to porous, highly altered material, appearance of kaolin somewhat soliceous. 100% C. R.
140	145	"	Light colored meta volcanics becoming highly broken. 100% C. R.
145	155	"	70% C. R. Same as above. Considerable oxidation. Alteration to Al-Si at 149-150'. Alteration back to meta volcanics at 150'. Light ground mass. 100% C. R. Rock mass solid 150-155'.
155	160	"	Continuing meta volcanics. Same as above to 156' where alteration takes place to Al-Si minerals, which continues to 158' where material becomes marginal, 160'. 100% C. R.
160	165	"	Al-Si material quits at 160' and material is light colored meta volcanics. Continues to 161' when ore mineralization occurs again, which continues to 165' where ore zone is of good quality. 80% C.R.
165	170	"	Ore zone continues to 166' where alteration takes place to meta volcanics. G. C. R.
170	175	"	Continuing meta volcanics. 80% C. R.
175	180	"	Changing to darker meta volcanics, continuing to 180'. 100% C. R.
180	185	"	Same as above. 100% C.R.
185	190	"	Some Al-Si mineralization at 186'. Hematite seams showing in meta volcanics at 186-187'. Meta volcanics continuing bluish cast at 187.5'. 100% C. R.
190	195	"	Continuing meta volcanics. Lean ore showing at 192-193', changing back to meta volcanics which continues to 195'. 100% C.R. Dark Cast.
195	200	"	Continuing dark colored meta volcanics. Some Al-Si mineralization. 100% C.R.
200	205	"	Same as above to 204' where Al-Si mineralization changes to definite ore zone. 100% C.R.
205	213	"	Same as above. 100% C.R. Bottom of hole.

Bismark No. 1 Mine
Mineral County, Nev.

Docket No. DMEA-9519
Contract No. Idm-F4b7

Diamond Drill Log - Hole No. 1
Strike 209 W. Dip 90°

Feet From	Feet To	Core Size	Description
0	8	"	Meta volcanics and overburden. 6-8' Lime and clay structure, light ground mass. 7-8' meta volcanics with schistose structures. 95% C. R.
8	14	"	8-10'; Same as 7-8'. 10-12': meta volcanics, alteration to schist-like structure, dark ground mass. 12-14': meta volcanics with schistose structure. Darker at 14'. Grey-blue in color. 100% C. R.

Docket No. DMEA-2512
Contract No. Idm-2457

Bismark No. 1 Mine
Mineral County, Nevada

Diamond Drill Log - Hole No. 1
Strike 70° N. Dip-30°

Feet From	Feet To	Core Size	Description
14	19	"	Dark blue colored metal volcanics. 14-16' where color changes to grey color, brecciated with schistose structure. Core breaks along planes of the schist. 17-18': andesite structure with some mineralization. Tendency towards brecciation. 18-19': continuing schistose structure lighter in color from 18-19'. 100% C. R. Ore showing 18-19'.
19	23	"	19-20': ore structure. 20-23': very pronounced schistose structure. Tendency towards brecciation. Predominant meta volcanics.
23	25	"	Same as above. at 24.5' some iron stain. 80% C. R.
25	29	"	100% C. R. 25-26': broken up schostose structure to 26'. Alteration to mineralization. continuing 26-29'. Ore structure at 28-29'. 100% C. R. Diaspore showing at 29'.
29	34	"	29-31': alteration to quartz. Showing indication of diaspore. 31-32': alteration to meta volcanics with considerable hematite stain. Alteration at 32' to ore zone to 34'. 100% C. R.
34	43	"	Ore zone. Good quality. very small seams of vugs of white quartz. 80% C. R. Core showed difficulty in drilling.
43	48	"	Quartz-like structure with mineralization. Ore showing through core. 80% C. R. Better quality ore showing at 48'.
48	52	"	Ore showing to 52'. Some quartzite. Glass-like. 80% C. R.
52	57	"	Ore showing. Considerable quartz in ore. Solid structure. Minor change at 57'. Oxidized surfaces. 100% C. R.
57	67	"	Some quartz seams through ore. Good quality ore showing at 53'. Alteration at 64' to quartz. Quartz showing to 67'. Some light colored material similar to feldspar. 70% C. R.
67	68	"	Light colored schist, showing some mineralization. Considerable quartz showing. 67-68' ore quality increasing rapidly. Ore zone. 100% C. R.
68	74	"	General ore zone. Diaspore showing with some pyrophylite crystals showing. 50% C. R.
74	80	"	74-75.5, ore zone altering to schist. Broken up at 77-80', considerable brecciation. 80% C. R.
80	83	"	Alteration to light colored meta volcanics with schistose structure. 90% C. R.
83	88	"	Darker colored meta volcanics at 83' showing alteration of phenocrysts. 40% C. R.
88	91	"	Same as above except lighter in color. No mineralization. 100% C. R.
91	95	"	Same as above to excepting quartzite seam at 92'. 60% C. R.
95	104	"	Dark colored meta volcanics, broken up. 50% C. R. 97-104' dark colored meta volcanics with considerable quartz shot through. Broken up to 98'. Lighter colored meta volcanics. Grey-banded structure. At 101-102, 102-103', clay-like. Plate structure. Light colored changing to highly mineralized Al-Si. Ore zone at 104'. 70% C.R.

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Docket No. DMEA-2512
Contract No. Idm-5457

Bismark No. 1 Mine
Mineral County, Nevada

Diamond Drill Log - Hole No. 1
Strike 70° W. Dip-30°

Feet From	Feet To	Core Size	Description
104	109	NX-37	General ore zone. Somewhat broken up. 90% C.R
109	115.5	"	Same as above. 80% C. R.
115.5	120	"	Ore zone - 117. Less mineralization to 120'. Solid structure to 120'. Some small seams of quartz at 117'. 90% C. R.
120	125	"	Alteration to meta volcanics at 120' continuing to 122' where alterations take place to pronounced schistose structure. Highly broken up. 100% C. R.
125	130	"	Highly broken up material to 127'. Schist and clay structure. 127'-alteration, to meta volcanics. Mineralized at 128'. Increasing mineralization to 130'. 100% C. R.
130	135	"	Soft clay material at 130'. Light buff coloring. Small seams of nontronite at 133-134'. 90% C. R.
135	140	"	Change to AX Core. Quartz and shale. 10% C. R.
140	145	"	Shaly meta andesite. Schistose structure. 50% C.R.
145	150	"	Same as above. 50% C. R. Bottom of hole.

Bismark No. 2
Mineral County, Nevada

Diamond Drill Log - Hole No. 2
Strike S 70° E, Dip-30°

Feet From	Feet To	Core Size	Description
0	15	"	Overburden. Sand
15	22	"	Meta andesite highly broekn up and light grey ground mass with white colored chenocrysts. 60% C. R.
22	27	"	Same as above.
27	32	"	Schistose structure to 28'. Alteration to sericite to 32'. 40% C. R.
32	37	"	Green sericite to 35', broken up. Alteration to light grey meta andesite. Some iron stain at 37'. 100% C. R.
37	42	"	Light grey andesites with pronounced schistosity 100% C. R.
42	45	"	Same as above with quartz intrusions.
45	48	"	Light colored meta andesites with schistose planes nearly parallel with drill hole. 100% C.R.
48	56	"	Same schistosity to 51'. Broken country at 51-56'. Schist. 50% C. R.
56	60	"	Solid formation at 56'. Considerable mineralization at 56-60'. Badly broken up from 57-60'. White fine grained material closely resembling texture of Al-Si ore. 100% C. R.
60	71	"	Continuing high mineralization to 66'. More solid formation. 80% C. R. 66-71' continuing mineralization. 40% C. R. Broken up. Light ground mass.
71	76	"	Light sandy material appearing to be diasspore. No C. R.
76	80	"	Solid formation. Quartzite with mineralized seams-very light colored. 100% C.R.
80	85	"	Same as above, with sericite in seams. 100% C.R. Appearance of feldspar.
85	91	"	Continuing quartzite. Sericite percentage increasing and at 90' ore zone. 91'. 90% C.R. Broken up at 90-91'.

Docket No. DMEA-2512
Contract No. I4m-7457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole No. 2
Strike S 70° E, Dip-30°

Feet From	Feet To	Core Size	Description
91	96	NX-37	91-93', ore zone. Less mineralization. 90% C.R. More solid formation.
96	101	"	Quartzite material light colored ground mass. Little mineralization. 60% C. R.
101	106	"	White colored ground mass. Opaque, very finely crystalline, some sericite. 90% C. R. Appears to be quartzite. Alteration at 106' to mineralization.
106	112	"	General ore zone. Diaspore. Some buff colored material. 90% C. R.
112	116	"	Ore zone. Very solid core. 100% C. R.
116	121	"	Ore zone. 100% C. R.
121	125	"	Continuing ore zone. 125'. 100% C. R.
125	130	"	Less mineralized in light ground mass to 127'. Ore zone-130'. 80% C. R.
130	134	"	Broken up country to 134'. Highly mineralized ore showing in places. 40% C. R.
134	140	"	Mineralized zone up to 140'. Buff colored ground mass. 70% C. R.
140	144	"	Ore zone. Light buff in color. 90% C. R.
144	146	"	Same as above. 100% C. R.
146	151	"	Same as above. Diaspore crystals evident. 100% C. R.
151	156	"	Ore zone. 100% C. R.
156	161	"	Very broken up ore zone. Poor core recovery. 20% C. R.
161	166	"	Poorer quality ore zone. Some intrusion of andesite. Banded structure. 50% C. R. At 163' alteration to andesites with occasional mineralization to 166'.
166	169	"	Schistose structure, some mineralization in meta andesites
169	174	"	Same as above. More mineralized. 30% C. R.
174	181	"	Meta andesites with zone of quartzite at 176-181'. 40% C. R.
181	196	"	Continuing quartzite with some pyrophyllite showing. Some ore showing at 191-196'. Highly broken up. 20% C. R. Some Diaspore showing.
196	200	"	Schistose structure at 198. Altering to black metal volcanics. Very poor C. R. 5%. Bottom of hole.

Diamond Drill Log - Hole #3
Strike N 70°W, Dip 30°

Feet From	Feet To	Core Size	Description
2	2.5	NX	Few inches of schistosed meta volcanics.
2.5	7	"	Quartzite. Solid formation. 60% C. R.
7	10	"	Quartzite. Solid formation. 80% C. R.
10	15	"	Same as above. 80% C. R.
15	20	"	Slight alteration of quartzite at 15'. Reddish brown hematite stain which continues to 20'. C. R. 40%. C. R. 100%.
20	23	BX	Quartzite with reddish stain to 23'. 100% C. R. Solid formation.
23	27	"	50% C. R. Mineralization starts at 23'. Light green, small areas shot through core. Mineralization increasing to 27'.
27	32	"	Mineralization continuing. Material more broken up. Light ground mass, appears to be mixture of quartzite and Al-Si minerals 40% C. R.

Docket No. OMSA-2519
Contract No. Idm-2457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole #3
Strike N 70°W, Dip 30°

Feet From	Feet To	Core Size	Description
32	35	BX	Mineralization or low grade ore continuing to 34' where quality increases to a general ore zone which continues to 35'. 80% C. R.
35	41	"	Solid core, general ore zone. 75% C. R.
41	46	"	Ore zone becoming quite lean at 41' where quartzite is becoming predominant, country more broken up. 50% C. R.
46	50	"	60% C. R. Ore and quartzite-country broken up
50	55	"	Material at 50' still broken, green Al-Si minerals more predominant. Mineralization decreasing to 53' where quartzite is predominant. 75% C. R.
55	60	"	10% C. R. Highly broken up ore zone. Schistosed material.
60	63	"	10% C. R. Same as above.
63	65	"	50% C. R. Alteration at 63'. Reddish honey combed material with some mineralization. Material becoming highly schistosed at 64'. Green Al-si minerals.
65	70	"	90% C. R. Continuing schistose structure. Occasional green Al-si minerals showing. Alteration at 67' to schistose meta volcanics with oxidized surfaces, continuing to 70'.
70	75	"	Waxy surfaces on shear planes. Plate like partings. 100% C. R.
75	81	"	70% C. R. Same as above. Platy structure more predominant.
81	86	"	Dark ground mass still prevailing (meta volcanics, country broken up. 50% C. R.
86	91	"	50% C. R. Same as above. Some mineralization.
91	95	"	Material alters to a light colored schistosed structure-slight mineralization. Platy surfaces. Continues to 94' where mineralization increases to 95'. 90% C. R.
95	100	"	C. R. 20%. Broken up country, some mineralization showing in the schist.
100	105	"	Continuing schist to 102' where alteration occurs to darker meta andesites which continues to 105'. 100% C. R. Country not quite so broken.
105	111	"	100% C. R. Dark meta andesites. Some oxidized surfaces continuing to 111'.
111	116	"	At 111', country very broken, schistosed light material to 114' where alteration to dark meta andesites takes place which continues to 116' in massive structure. 80% C. R.
116	121	"	Continuing dark, massive meta andesites to 121'.
121	126	"	40% C. R. Highly broken and dark colored meta andesites.
126	131	"	Very poor core recovery - less than 10%. Same as above.
131	136	"	No C. R.
136	141	"	Less than 5% C. R. Highly broken meta andesites.

Docket No. DMEA-2512
Contract No. Idm-5457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole #3
Strike N 70° W, Dip 30°

Feet From	Feet To	Core Size	Description
141	146	AX	Poor core recovery, some mineralization showing in meta andesites.
146	151	"	Soft sandy material showing with small pieces of ore. Country highly broken. Very poor core recovery.
151	161	"	10% C. R. Schistosed structure with considerable mineralization, highly broken up.
161	166	"	Alteration to grey to reddish material sandy in structure. 50% C. R.
166	171	"	Continuing soft broken up material, reddish and grey mixture to bottom of hole.

Diamond Drill Log - Hole #4
Strike No. 70°W - Dip-45°

Feet From	Feet To	Core Size	Description
0	6	NX	Overburden
6	10	"	80% C. R. General ore zone, core solid.
10	16	"	Same as above, solid formation 100% C. R.
16	23	"	General ore zone continuing. Broken up country at 21' to 23'. 100% C. R.
23	30	"	Ore zone continuing to 26' where alteration to meta volcanics occurs with some mineralization. 60% C. R.
30	36	BX	80% C. R. Ore zone at 30', continuing-36'.
36	39	"	36'-39', brecciated material with schistosity. 37'-39' alteration back to ore zone. 80% C. R.
39	44.5	"	Ore zone continuing to 43', quite broken up. Alteration at 43' to very dark meta volcanics. 70% C. R.
44.5	49	"	90% C. R. Continuing dark meta volcanics, solid formation.
49	53	"	Continuing meta volcanics to 50' where country is broken and lighter in color. Alteration at 51' to green Al-Si minerals.
53	59	"	20% C. R. Ore continuing to 54' where shaly or platy structure occurs, light ground mass, some mineralization.
59	64	"	Broken up country to 61', loose material showing some ore. 61-64', badly broken up schistose structure. 80% C. R.
64	75	"	Alteration to dark platy shale at 69' which continues to 70' where material is of massive dark meta andesites, which continues to 75'. 40% C. R.
75	80	"	Continuing dark meta andesites which continue to 78'. 80% C. R.
80	83	"	Same as above. 75% C. R.
83	86	"	Considerable quartz showing in dark meta andesites, also porphrytic structure with some feldspars scattered throughout. 75% C. R.
86	91	"	100% C. R. Dark meta andesites, solid formation.
91	96	"	100% C. R. Same as above. No mineralization.

Docket No. DMEA-2512
Contract No. Idm-E457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole #4
Strike N 70°W - Dip-45°

Feet From	Feet To	Core Size	Description
96	102	BX	90% C. R. Same as above.
102	107	"	Continuing dark meta andesites with small phenocrysts. 100% C. R.
107	109	"	75% C. R. Same as above except for occasional quartz seams.
109	114	"	80% C. R.
114	120	"	Same as above, 90% C. R.
120	125	"	Same as above, 50% C. R.
125	128	"	Broken up country beginning at 127'. Lighter ground mass. 50% C. R.
128	134	"	Schistosed structure, some mineralization. 50% C. R.
134	139	"	5% C. R. Broken up country, light ground mass.
139	145	"	30% C. R. Ore showing at 139' which continues to 145', low grade.
145	147	AX	80% C. R. Some mineralization continuing to 147' in dark ground mass.
147	150	"	50% C. R. Broken up country, some mineralization, dark in color.
150	155	"	20% C. R. Very badly broken, dark material; Meta andesite.
155	160	"	40% C. R. Formation more solid, dark meta andesite.
160	165	"	20% C. R. Same as above.
165	170	"	Poor C. R. Same as above with slight mineralization.
170	175	"	50% C. R. Continuing predominance of meta andesites with slight mineralization.
175	180	"	10% C. R. Same as above.
180	185	"	Dark meta andesite, badly broken, 20% C. R.
185	190	"	Same as above. Poor C. R.
190	195	"	40% C. R. Formation more solid. Black meta andesite.
195	200	"	Same as above with some mineralization. 40% C. R.

Diamond Drill Log - Hole #5
Strike N 70°W - Dip-45°

Feet From	Feet To	Core Size	Description
3	11	NX	Solid formation, general ore zone, light in color with green Al-Si minerals throughout. 85% C. R.
11	16	"	90% C. R. Ore zone continuing, appears to be lower in grade up to 16'. Very solid formation.
16	21	"	20% C. R. Alteration at 16', siliceous structure. Light ground mass. Highly broken up.
21	26	"	Country not quite so broken, some schistosed structure. 2% C. R.
26	28.5	"	Formation solid; highly siliceous at 28' mineralization increasing to general ore zone at 28'. 90% C. R.
28.5	31	"	General ore zone, solid core, slightly darker in color. 80% C. R.
31	35	"	Highly broken up country, schistosed structure, with abundant green Al-Si minerals. 10% C. R.
35	41	"	Formation more solid at 35'-38'. General ore zone-broken up from 36'41', quartz seam at 40-41'. Broken up country. 80% C. R.

Docket No. DMEA-2512
Contract No. Idm-E457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole #6
Strike N 70° W - Dip-45°

Feet From	To	Core Size	Description
41	46	NX	Schistosed structure at 41' continuing, 44', General ore zone, 44-46' ore zone formation more solid. Some oxidized surfaces. 60% C. R.
46	61	"	Broken up ore zone, 46-47'. Formation solid from 47-51'. General ore zone continuing to 51', good quality, 100% C. R.
51	56	"	General ore zone continuing. Country more broken up which continues to 52'. Formation solid from 52'-56'. General ore zone. 60% C. R.
56	61	"	At 56-57' slight change in structure, highly iron stained ore zone. Formation solid and ore zone continues. Blue green cast. 100% C. R.
61	66	BX	General ore zone continuing, unusual mineralization at 62'. Light in color with off color green veinlets. Country more broken up. 60% C. R.
66	71	"	General ore zone continuing. Solid formation. 100% C. R.
71	75.5	"	80% C. R. Same as above.
75.5	81	"	Same as above. 70% C. R. Country somewhat broken.
81	86	"	Ore more quartzite at 81' increasing in quality up to 86'. 70% C. R.
86	91	"	Low grade ore to 91'. Country somewhat broken with quartz seam interruption. 60% C. R.
91	93	"	Some character ore to 93'. 75% C. R. Buff in color!
93	95	"	Ore zone, low in grade. Quite siliceous. Small crystals of meta volcanics shot through. 75% C. R.
95	100	"	General ore zone. Quite siliceous, appearing to be higher in grade. 70% C. R.
100	105	"	70% C. R. Better grade ore zone continuing up to 105'.
105	108	"	50% C. R. Continuing ore zone.
108	111	"	40% C. R. Same as above.
111	114	"	Ore continues solid to 114' where alteration takes place to grey meta andesites. 30% C. R.
114	117	"	Meta andesites continuing to 116' where alteration takes place to general ore zone, darker in color, reddish. Continues to 117', 70% C.R.
117	120	"	50% C. R. Continuing ore zone. Reddish in color, somewhat broken up.
120	124	"	Ore zone continuing to 124'. Lighter in color to 122' and darker from 122-124'. 80% C. R.
124	127	"	General ore zone continuing-127' lower in grade from 126-127'. 100% C. R.
127	132	"	Somewhat siliceous ore to 128'. Very solid core from 128-131'. General ore zone. 100% C. R.
132	136	"	75% C. R. Low grade ore zone. Formation solid. Quite siliceous in appearance.
136	139	"	Same as above. 70% C. R.
139	142	"	2% C. R. Same as above.
142	146	"	30% C. R. Same as above, except darker in color.
146	151	"	Ore zone, lighter in color, 10% C. R.
151	156	"	20% C. R. Platy ore structure broken.

Docket No. DMEA-2512
Contract No. Idm-E457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole #5
Strike N 70°W - Dip-45°

Feet From	To	Core Size	Description
156	161	BX	Broken up country- general ore zone. 20% C. R. Low in grade; more massive.
161	166	"	Same as above.
166	171	"	10% Same as above; platy structure.
171	176	"	Alteration at 171' to schistosed ore structure low in quality. Poor core recovery.
176	179	"	P. C. R. Highly schistosed structure. Bottom of hole.

FORM 407

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881

PITTSBURGH, PA.

AS A MUTUAL PROTECTION TO CLIENTS, THE PUBLIC AND OURSELVES, ALL REPORTS ARE SUBMITTED AS THE CONFIDENTIAL PROPERTY OF CLIENTS, AND AUTHORIZATION FOR PUBLICATION OF STATEMENTS, CONCLUSIONS OR EXTRACTS FROM OR REGARDING OUR REPORTS IS RESERVED PENDING OUR WRITTEN APPROVAL.

ORDER No. SF 657 651 Howard St. San Francisco LABORATORY No.

CLIENT'S No. FILE No.

REPORT

August 31, 1953

Coranda Corporation
386 Race Street
San Jose, California
Attention: Mr. J. H. Rodda, President

Subject: Analysis of Sillimanite Minerals

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	Ignition Loss
1-1	52.86%	29.20%	6.58%	0.41%	0.50%	.75%	0.44%	3.30%	Trace	4.11%
2-1	53.38	28.90	5.44	0.80	0.15	.58	0.48	3.74	"	3.65
3-1	53.82	27.80	6.86	0.52	0.44	.33	0.58	4.75	"	3.64
4-1	60.10	24.80	6.02	0.48	0.10	.47	0.37	2.72	"	3.28
5-1	60.32	25.55	5.01	0.33	0.41	.65	0.42	2.90	"	3.10
6-1	50.28	36.30	2.48	0.94	0.30	0.97	0.58	3.40	"	3.97
7-1	42.02	41.20	3.43	0.70	0.35	1.10	0.67	5.60	"	3.94
8-1	61.58	22.40	6.64	1.17	1.25	0.65	0.38	2.13	"	2.43
9-1	62.64	25.70	2.81	1.00	0.22	0.95	0.42	3.65	"	3.10
10-1	57.96	25.70	3.61	0.40	0.32	0.97	0.60	6.70	"	2.97
12-1	53.70	21.40	5.08	1.07	0.25	0.90	0.38	2.36	"	2.94
16-1	47.74	36.90	3.48	0.44	1.05	0.60	0.46	3.40	"	3.93
17-1	64.70	20.30	3.80	1.04	0.32	0.76	0.43	4.33	"	5.99
18-1	57.22	30.50	1.69	0.78	0.34	0.65	0.48	2.70	"	3.67
19-1	45.64	37.80	7.90	0.95	0.33	0.50	0.55	4.20	"	0.28
B4-2	62.52	28.45	5.29	0.68	0.26	0.52	0.28	1.67	"	0.36
B5-2	69.52	21.00	3.15	1.09	0.32	0.63	0.27	2.50	"	0.21
B7-2	67.88	16.60	3.08	0.78	0.31	0.70	0.38	6.50	"	2.02
B8-2	93.12	4.00	0.86	1.12	0.40	0.74	0.21	0.45	"	0.23
B9-2	91.44	4.20	0.66	0.78	0.28	0.63	0.27	0.93	"	0.51
B10-2	91.34	4.80	0.86	1.12	0.24	0.61	0.20	0.60	"	0.29
B11-2	88.12	6.15	0.57	1.43	0.32	0.65	0.29	1.43	"	0.41
B12-2	83.00	12.55	0.75	1.37	0.26	0.54	0.22	0.83	"	1.06
B14-2	83.60	12.50	0.83	1.48	0.26	0.54	0.15	1.33	"	0.49
B15-2	72.56	23.95	1.03	0.69	0.20	0.35	0.13	0.17	"	0.97
B16-2	69.52	25.45	1.09	1.23	0.23	0.38	0.07	0.15	"	0.97
B17-2	72.74	21.35	1.63	1.10	0.31	0.38	0.22	0.13	"	0.95
B18-2	74.00	22.85	1.95	0.78	0.32	0.39	0.14	0.05	"	1.12
B19-2	65.22	28.15	1.77	0.78	0.27	0.32	0.14	0.40	"	1.54
B20-2	66.36	26.90	2.84	1.29	0.32	0.41	0.20	1.27	"	1.72
B21-2	69.14	22.05	2.23	0.98	0.25	0.37	0.22	1.45	"	2.69
B22-2	72.46	18.50	3.18	1.12	0.36	0.46	0.20	1.40	"	2.25
1-3	51.50	31.80	1.92	0.95	0.48	0.82	0.41	7.90	"	4.03
2-3	63.18	18.40	7.59	1.17	0.38	0.79	0.35	2.85	"	3.82
3-3	64.70	22.60	1.32	1.01	0.34	0.73	0.27	4.47	"	2.88
4-3	65.72	20.60	1.49	0.85	0.20	0.28	0.33	5.81	"	2.76
5-3	72.98	15.60	0.97	1.38	0.19	0.24	0.30	5.50	"	2.10
9-3	69.32	15.75	4.73	0.68	1.40	0.91	1.41	1.87	"	2.64

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ORDER No. SF 657 651 Howard St. San Francisco LABORATORY No.

CLIENT'S No. FILE No.

REPORT

August 31, 1953

Coranda Corporation
386 Race Street
San Jose, California

Attention: Mr. J. H. Rodda, President

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	Ignition Loss
14-3	51.56%	34.05%	1.43%	0.05%	0.18%	0.17%	0.49%	6.40%	Trace	4.00%
16-3	58.58	30.00	1.71	1.08	0.21	0.30	0.50	4.65	"	2.54
17-3	45.70	40.65	1.89	1.25	0.33	0.48	0.43	4.40	"	4.29
3-4	62.86	28.20	1.02	1.22	0.33	0.49	0.30	2.82	"	2.08
4-4	65.14	26.95	4.11	1.08	0.29	0.35	0.13	0.88	"	1.29
5-4	66.60	24.90	2.29	0.98	0.31	0.22	0.21	1.87	"	2.10
7-4	68.50	18.50	5.84	0.95	0.37	0.55	0.19	1.55	"	1.65
8-4	68.60	14.85	7.83	0.95	0.28	0.53	0.61	2.55	"	1.68
9-4	73.60	10.40	11.51	1.38	0.32	0.56	0.64	0.93	"	1.11
10-4	82.18	6.45	7.16	1.17	0.27	0.49	0.34	0.38	"	0.47
11-4	93.36	0.85	1.33	1.17	0.22	0.41	0.61	3.01	"	0.05
16-4	73.50	19.40	1.23	0.93	0.17	0.32	0.43	2.35	"	2.26
17-4	67.50	25.80	2.09	0.92	0.19	0.41	0.59	2.52	"	1.95

Respectfully submitted,

PITTSBURGH TESTING LABORATORY

Carlton M. Robinson

District Manager

SS
bk
cc: 10 above

FORM 407

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881

PITTSBURGH, PA.

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ORDER No. SF 657 651 Howard St. San Francisco LABORATORY No.

CLIENT'S No. FILE No.

REPORT

September 30, 1953

Coranda Corporation
386 Race Street
San Jose, California
Attention: Mr. J. H. Rodda, President

Subject: Analysis of Sillimanite Minerals

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	Ignition Loss
11-1	60.56%	24.00%	5.35%	0.64%	0.27%	0.34%	0.78%	3.95%	Trace	2.55%
15-1	59.64	25.30	5.15	1.09	0.63	0.33	0.65	3.45	"	2.38
20-1	60.98	23.25	1.48	1.47	1.87	0.46	0.98	4.50	0.01	3.09
B5-1	64.06	25.10	6.20	1.00	0.20	0.11	0.28	2.85	Trace	2.03
B8-1	60.64	32.65	1.95	0.98	0.06	0.02	0.12	0.70	"	1.07
B11-1	76.26	21.45	0.88	1.27	0.02	0.02	0.04	0.42	"	0.77
B13-1	71.14	25.40	0.54	1.08	0.09	0.02	0.05	0.58	"	0.88
B15-1	69.28	25.55	0.60	1.03	0.04	0.02	0.09	0.70	"	2.38
B20-1	68.44	26.40	1.08	1.05	0.03	0.02	0.07	0.70	"	1.36
10-2	60.66	19.55	6.10	1.95	2.85	1.75	0.36	3.20	0.15	5.07
11-2	59.48	19.75	5.85	0.82	1.15	0.73	0.55	3.75	0.10	5.88
18-2	60.48	27.30	0.94	1.15	0.10	0.15	0.52	5.15	Trace	3.40
19-2	57.00	26.90	1.25	0.85	0.45	0.27	0.73	6.90	"	3.90
20-2	55.60	29.10	1.62	0.48	0.52	0.52	0.75	6.50	0.01	3.42
21-2	50.28	33.00	1.70	0.69	0.73	0.53	0.91	8.10	0.01	3.89
22-2	51.24	31.10	1.88	0.79	0.84	0.64	0.81	7.30	0.01	3.68
24-2	51.90	31.65	2.13	0.96	0.83	0.42	0.91	7.40	0.01	3.65
26-2	56.54	23.45	8.95	0.91	0.57	0.07	0.47	4.50	0.01	2.81
27-2	55.42	24.70	7.80	1.15	0.72	0.07	0.52	4.55	Trace	3.15
30-2	82.12	10.55	1.45	1.02	0.20	0.05	0.15	1.51	"	1.18
31-2	52.32	31.05	2.30	0.74	0.14	0.14	0.81	7.40	0.01	4.02
33-2	56.02	26.65	5.90	1.22	0.24	0.24	0.64	5.75	Trace	2.98
34-2	56.48	23.85	6.70	1.15	0.55	0.17	0.65	6.10	"	3.07
35-2	62.60	23.95	2.85	0.95	0.15	0.07	0.46	4.45	"	3.05
36-2	57.00	28.90	2.55	1.17	0.41	0.53	0.62	4.95	"	3.17
37-2	44.12	38.05	2.30	1.12	0.45	0.31	0.98	10.50	"	4.02
38-2	53.74	26.50	8.20	1.17	0.87	0.15	0.45	4.70	"	2.95
39-2	57.16	26.20	2.55	1.12	0.46	0.19	0.89	9.50	"	3.75
40-2	62.74	24.90	2.10	1.10	0.08	0.37	0.48	4.25	"	2.66
41-2	52.50	32.40	2.35	0.97	0.12	0.63	0.69	5.40	"	2.91
42-2	57.30	27.10	3.55	1.00	0.48	0.47	0.76	7.65	"	3.60
43-2	56.40	27.00	3.10	0.73	0.44	0.46	0.58	6.10	"	3.64
44-2	53.62	28.00	3.60	0.87	0.35	0.78	0.76	7.10	"	3.73
B3-2	69.40	16.80	4.95	0.18	0.77	0.56	0.80	3.35	0.13	1.13
[illegible]-3	77.68	10.70	6.15	1.05	0.08	0.22	0.17	1.95	Trace	1.75
15-3	63.96	22.25	1.12	2.90	0.81	0.17	0.53	4.00	"	2.30
18-3	40.82	29.95	13.70	1.13	1.60	0.39	0.92	6.35	"	3.33
19-3	53.40	22.70	16.45	1.00	0.79	0.29	0.49	3.25	"	2.61

FORM 407

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881

PITTSBURGH, PA.

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ORDER No. SF 657

651 Howard St. San Francisco

LABORATORY No.

CLIENT'S No.

FILE No.

REPORT

September 30,1953

Coranda Corporation

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	Ignition Loss
20-3	57.88%	19.45%	12.60%	0.85%	0.68%	0.23%	0.57%	3.35%	Trace	2.73%
B4-3	86.46	8.45	0.82	1.02	0.03	0.07	0.07	1.05	"	0.60
B8-3	65.50	22.05	4.15	0.93	0.04	0.46	0.25	3.80	"	2.11
B11-3	56.62	22.85	8.80	0.90	0.22	0.30	0.32	5.50	0.02	2.64
B13-3	78.14	7.05	8.50	1.02	0.21	1.78	0.20	2.80	0.06	1.93
B17-3	49.98	32.88	2.95	0.39	3.40	0.78	1.15	3.45	0.16	4.30
2-4	58.24	17.70	15.50	1.20	0.65	2.18	0.18	1.95	0.17	1.48
18-4	52.42	42.65	0.57	0.78	0.06	0.03	0.13	0.78	Trace	2.63
19-4	53.86	38.05	0.93	0.78	0.03	0.09	0.18	1.43	"	2.56
20-4	59.42	34.55	0.61	0.44	0.06	0.05	0.16	0.50	"	2.18
21-4	63.46	24.85	2.46	0.86	0.39	0.28	0.15	0.33	"	0.81
22-4	73.78	15.05	2.25	0.47	0.12	0.37	0.14	1.92	"	2.12
23-4	74.46	15.55	2.23	0.75	0.10	0.86	0.60	2.15	"	2.11
24-4	72.60	15.80	2.54	0.26	0.14	0.84	0.64	1.55	"	1.77
25-4	59.12	17.90	16.25	1.00	0.41	0.82	0.48	2.60	0.02	2.05
26-4	55.28	22.75	10.75	0.73	0.73	0.16	0.94	5.45	Trace	2.87
B3-4	57.50	31.65	2.80	0.65	0.24	0.53	0.23	2.27	0.01	2.67
B8-4	59.68	26.15	3.30	0.65	0.23	0.58	0.33	4.05	Trace	3.42
B17-4	65.22	15.55	5.85	0.58	4.05	1.40	1.65	2.35	0.26	1.27
B25-4	49.34	25.70	12.50	1.02	1.41	5.00	0.16	1.90	0.35	2.17
1-5	48.70	31.65	4.20	1.02	1.14	0.96	1.85	8.30	Trace	4.37
3-5	48.42	32.75	3.35	0.91	0.16	0.87	1.65	8.35	0.01	4.75
4-5	49.82	45.15	0.76	0.75	0.06	0.03	0.19	0.85	Trace	2.81
5-5	56.78	38.05	0.98	1.20	0.03	0.02	0.19	0.71	"	1.72
5-5A	61.90	31.65	0.76	2.45	0.02	0.02	0.06	0.10	"	2.11
5-5B	60.22	34.65	0.69	1.62	0.02	0.01	0.14	0.47	"	1.80
5-5C	53.42	41.00	0.69	1.20	0.03	0.01	0.15	0.44	"	1.97
5-5D	70.46	24.45	0.70	1.95	0.03	0.02	0.04	0.09	"	0.78
5-5E	63.80	33.20	0.92	1.38	0.04	0.03	0.08	0.18	"	1.32
5-5F	62.92	33.90	0.81	1.43	0.06	0.03	0.23	0.88	"	1.79
7-5	65.88	25.70	1.14	3.15	0.04	0.05	0.13	0.65	"	1.38
8-5	72.28	18.60	2.17	4.00	0.05	0.06	0.09	0.37	0.02	1.04
9-5	72.54	22.95	0.92	1.68	0.02	0.02	0.04	0.15	Trace	0.90
10-5	69.24	22.45	3.02	1.32	0.04	0.09	0.24	1.10	"	2.38
11-5	50.08	34.40	1.53	1.34	0.03	0.19	1.38	7.00	"	3.93
12-5	76.90	14.80	0.98	4.30	0.02	0.06	0.08	0.37	"	0.62
13-5	69.34	18.04	2.50	1.45	1.72	0.36	0.45	2.64	0.15	2.66
14-5	76.54	17.50	0.86	1.34	0.09	0.04	0.21	1.18	0.01	1.03
[illegible]-5	78.22	13.75	0.47	1.62	0.26	0.04	0.31	2.33	Trace	1.62
18-5	73.44	17.90	0.69	1.28	0.08	0.08	0.34	2.65	0.02	2.06
21-5	48.74	33.85	1.58	0.64	0.10	0.64	1.20	9.50	0.01	4.05
22-5	53.50	31.80	1.40	1.08	0.14	0.27	0.97	8.90	Trace	

FORM 407

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ORDER No. SF657 651 Howard St. San Francisco LABORATORY No.

CLIENT'S No. FILE No.

REPORT

September 30,1953

Coranda Corporation

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	Ignition Loss
23-5	47.04	31.20	1.72	0.86	0.46	0.53	1.33	11.50	0.01	4.43
24-5	51.06	25.00	8.50	1.17	1.85	1.40	0.97	5.62	0.08	4.36
25-5	52.40	16.40	9.20	1.85	6.70	3.40	1.18	2.60	0.34	7.57
26-5	47.62	27.25	6.65	0.93	1.95	0.89	1.17	8.35	0.04	4.59
27-5	52.80	24.35	7.40	0.93	1.98	0.92	1.38	7.45	0.04	4.09
27-5A	55.00	38.90	0.65	1.32	0.05	0.03	0.08	0.75	Trace	1.84
28-5	60.34	22.05	6.80	0.81	1.85	0.78	1.20	4.55	0.05	3.20
29-5	64.42	17.45	7.05	0.62	3.50	1.00	3.30	2.20	0.17	1.97
30-5	57.68	15.80	18.04	1.80	6.15	2.55	1.13	2.35	0.17	4.01
31-5	51.86	15.10	16.20	2.12	3.65	3.25	0.82	2.50	0.22	6.21
32-5	54.82	17.50	15.75	1.22	2.10	2.70	1.08	2.18	0.24	3.25
B1-5	64.44	25.30	0.60	0.83	0.24	0.27	0.20	3.30	Trace	3.06
B6-5	66.86	27.90	0.36	0.38	0.04	0.03	0.10	1.30	"	0.99
B8-5	64.98	25.60	2.12	0.88	0.04	0.05	0.19	1.95	"	2.90
B15-5	77.56	13.55	3.30	0.90	0.01	0.03	0.13	1.40	"	1.15
B21-5	73.92	17.70	0.84	0.50	0.01	0.02	0.19	2.70	"	2.11
2-6	53.10	33.40	1.70	0.57	0.05	0.06	0.47	4.70	0.01	3.43
3-6	56.95	20.90	16.05	1.09	0.37	0.10	0.43	2.05	Trace	1.70
4-6	45.44	39.95	1.45	0.70	0.05	0.05	0.89	5.85	"	3.73
4-6A	57.08	31.50	2.38	0.89	0.10	0.12	0.46	2.90	"	2.66
5-6	56.80	33.75	1.22	1.02	0.06	0.07	0.44	2.85	"	2.47
6-6	53.50	32.70	0.70	1.04	0.15	0.08	1.12	6.05	"	3.65
7-6	71.06	19.80	3.05	0.25	0.11	0.57	0.91	2.70	0.03	2.48
9-6	56.98	33.35	0.69	0.62	0.10	0.07	0.36	3.30	Trace	2.53
10-6	63.80	31.40	0.70	1.15	0.08	0.02	0.09	0.43	"	1.80
11-6	61.30	32.65	1.00	1.03	0.06	0.02	0.21	0.89	"	1.74
12-6	59.70	34.80	1.12	0.82	0.05	0.02	0.27	1.45	"	1.97
13-6	59.46	30.95	3.85	0.91	0.08	0.24	0.32	1.40	"	1.92
14-6	61.04	34.35	0.95	0.94	0.09	0.06	0.21	1.08	"	1.76
15-6	62.66	33.95	0.92	0.94	0.06	0.04	0.06	0.22	"	1.61
16-6	62.82	32.70	0.72	0.66	0.06	0.02	0.04	0.18	"	1.94
17-6	61.88	34.75	0.90	0.94	0.12	0.01	0.05	0.12	"	2.20
18-6	64.94	29.80	0.71	0.86	0.05	0.02	0.03	0.09	"	1.72
19-6	64.30	31.60	0.67	0.82	0.04	0.02	0.04	0.13	"	1.15
20-6	56.64	37.65	0.60	0.75	0.07	0.02	0.05	0.24	"	2.20
21-6	60.24	32.70	1.52	0.74	0.05	0.02	0.21	0.94	"	1.98
27-6	53.70	19.80	16.55	1.03	0.47	0.22	0.63	3.55	0.01	2.39
28-6	51.82	29.35	6.50	0.78	0.73	0.19	1.05	6.05	0.01	3.67
5-7	61.40	20.40	5.85	0.72	0.61	0.67	1.60	4.90	0.03	3.48
6-7	53.92	25.60	2.55	0.78	0.13	0.23	0.74	9.30	Trace	4.40
7-7	45.88	34.45	7.50	1.00	0.80	0.50	0.51	5.20	0.01	3.27
8-7	56.04	19.90	17.55	0.91	0.38	0.91	0.20	1.45	0.04	1.53

FORM 407

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ORDER No. SF657 651 Howard St. San Francisco LABORATORY No.

CLIENT'S No. FILE No.

REPORT

September 30, 1953

Coranda Corporation

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	Ignition Loss
9-7	53.60%	17.80%	20.50%	1.07%	0.56%	0.82%	0.33%	3.00%	0.06%	2.03%
10-7	55.06	17.70	16.80	1.02	0.49	1.21	0.30	3.00	0.06	2.64
11-7	54.70	20.20	15.55	0.97	0.39	0.64	0.33	3.15	0.02	2.68
15-7	53.18	30.45	2.40	0.78	0.10	0.20	0.56	9.10	Trace	3.94
22-7	59.92	23.95	4.75	0.87	0.16	0.28	0.39	4.40	"	2.98
28-7	56.48	21.45	10.85	0.98	0.41	0.43	0.53	4.30	"	2.91

Respectfully submitted,

PITTSBURGH TESTING LABORATORY

Carlos M. Robinson

District Manager

SS
bk
cc: 16 - above

FORM 407

PITTSBURGH TESTING LABORATORY

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ORDER No. SF 657

651 Howard St. San Francisco

LABORATORY No.

CLIENT'S No.

FILE No.

REPORT

October 16,1953

Coranda Corporation
386 Race Street
San Jose, California.
Attention: Mr. J.H. Rodda, President

Subject: Analysis of Sillimanite Minerals

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	Ignition Loss
B1-1	66.70%	8.50%	12.50%	0.85%	3.85%	1.21%	0.12%	1.63%	0.07%	3.35%
B-2-1	61.80	20.60	9.30	0.96	0.30	0.89	0.15	2.60	0.07	1.80
B-3-1	59.22	21.25	9.20	0.91	0.20	0.71	0.33	4.40	0.02	2.42
B 4-1	61.66	24.85	3.95	0.60	0.16	0.08	0.39	4.40	0.01	2.49
B 6-1	69.86	22.55	3.35	0.64	0.07	0.03	0.18	1.22	Trace	0.99
B 7-1	70.80	23.50	2.00	0.93	0.03	0.02	0.12	0.86	Trace	1.01
B 9-1	67.22	29.55	0.79	0.92	0.02	0.02	0.05	0.15	Trace	0.97
B15-1A	55.62	35.20	0.42	1.87	0.08	0.03	0.13	0.94	Trace	4.52
B16-1	73.84	15.95	2.62	0.77	0.25	0.51	0.77	2.90	0.03	0.54
B17-1	68.28	20.90	3.25	0.23	1.25	0.68	2.55	3.45	0.15	0.52
B19-1	67.56	21.85	1.98	0.97	0.15	0.12	0.35	5.25	Trace	1.94
B21-1	67.20	24.30	3.45	0.80	0.05	0.01	0.08	0.67	Trace	1.77
B22-1	67.02	25.10	4.20	1.10	0.06	0.03	0.17	1.55	Trace	1.81
B23-1	51.42	19.45	11.90	0.91	0.35	0.78	0.30	4.10	0.05	2.29
B 9-3	62.68	22.65	6.30	0.85	0.07	0.37	0.31	4.45	0.03	1.41
B 10-3	58.36	20.85	11.20	0.88	0.29	0.36	0.38	5.30	0.04	1.48
B 12-3	57.62	18.45	12.20	0.88	0.33	2.65	0.22	3.15	0.08	2.84
B 14-3	61.26	20.80	6.90	1.12	0.28	1.18	0.26	4.90	0.12	1.63
B 15-3	57.16	19.30	9.75	0.85	4.90	2.40	0.19	2.95	0.28	1.68
B 16-3	66.34	17.80	6.30	0.61	3.45	1.43	0.69	2.80	0.21	1.31
B-18-3	71.90	13.85	2.57	0.32	2.05	0.62	0.75	3.25	0.09	2.73
B-19-3	71.46	14.25	2.57	0.58	1.70	0.59	0.53	2.95	0.08	4.09
B-20-3	62.20	25.25	3.90	1.32	0.37	0.69	0.26	2.15	0.02	2.69
B-21-3	49.68	17.05	10.40	1.40	8.10	2.10	3.05	2.18	0.11	7.58
B1-4	68.72	25.65	1.48	0.97	0.06	0.05	0.06	0.60	Trace	1.06
B2-4	67.64	25.95	1.12	0.89	0.06	0.04	0.07	0.81	Trace	1.78
B4-4	70.62	23.85	1.72	1.00	0.04	0.06	0.08	0.74	Trace	1.50
B5-4	68.62	22.70	4.80	1.15	0.06	0.04	0.10	1.03	0.02	1.71
B6-4	71.68	20.65	2.95	0.82	0.04	0.08	0.15	1.75	0.01	2.03
B7-4	55.36	17.95	15.60	0.97	0.47	2.25	0.20	2.65	0.20	2.38
B9-4	61.32	21.80	5.30	0.94	0.22	0.48	0.31	4.85	0.01	3.66
B-10-4	64.22	21.65	3.35	0.86	0.32	0.13	0.31	4.85	Trace	3.60
B11-4	71.18	15.35	4.75	0.40	1.70	0.81	2.75	2.55	0.13	1.51

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ORDER No. SF 657

LABORATORY No.

651 Howard St. San Francisco

CLIENT'S No.

FILE No.

REPORT

October 16,1953

Coranda Corpor tion
386 Race Street
San Jose, California.
Attention: Mr. J.H. Rodda, President

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	Ignition Loss
B12-4	72.50%	13.95%	2.85%	0.16%	2.05%	0.72%	2.60%	2.20%	0.12%	0.83%
B13-4	71.74	13.10	3.45	0.16	3.55	0.73	2.65	2.38	0.18	0.47
B14-4	61.04	15.40	8.40	0.83	5.95	1.85	1.73	2.37	0.30	0.81
B15-4	67.12	12.75	6.75	0.45	5.00	1.37	3.30	1.75	0.25	0.57
B16-4	66.66	16.35	4.15	0.45	4.65	1.18	2.50	2.15	0.24	0.34
B18-4	67.00	14.95	8.60	1.06	0.59	0.95	0.32	3.50	0.03	2.19
B19-4	54.56	14.05	17.00	1.08	0.85	4.25	0.26	2.55	0.27	4.41
B20-4	53.96	13.20	16.50	1.22	0.83	4.30	0.31	3.10	0.26	3.83
B21-4	51.52	15.50	17.90	1.11	0.45	4.55	0.17	2.15	0.25	4.66
B23-4	54.16	16.70	15.95	1.08	1.11	4.35	0.20	2.40	0.29	1.87
B24-4	51.90	16.50	18.50	1.12	1.50	4.75	0.22	1.75	0.33	2.28
B26-4	55.86	17.20	13.30	0.84	1.21	4.75	0.16	1.95	0.32	2.46
B11-5	93.74	4.25	0.72	1.32	0.01	0.04	0.07	0.68	Trace	0.70
B12-5	74.14	21.25	0.35	1.70	0.01	0.02	0.05	0.46	Trace	0.68
B13-5	80.66	13.80	0.49	1.85	0.01	0.03	0.07	0.68	Trace	0.66
B14-5	76.86	21.60	0.57	0.98	0.01	0.02	0.07	0.74	Trace	0.90
B16-5	63.96	22.50	9.40	1.52	0.02	0.05	0.15	1.02	Trace	1.07
B17-5	61.16	32.95	1.13	1.07	0.01	0.02	0.09	0.88	Trace	1.09
B18-5	80.44	15.05	0.82	1.10	0.01	0.02	0.01	0.29	Trace	0.63
B19-5	84.22	13.55	0.47	1.10	0.01	0.02	0.06	0.72	Trace	1.19
B20-5	70.34	20.95	0.73	0.83	0.01	0.01	0.17	2.30	Trace	2.74
B22-5	81.80	8.40	2.65	0.83	0.01	0.25	0.14	2.50	Trace	2.40
B23-5	69.94	12.30	6.90	1.03	0.02	0.75	0.23	4.20	0.02	2.70
22-6	62.42	26.90	5.05	0.74	0.13	0.05	0.35	1.19	Trace	1.59
23-6	54.98	25.65	8.10	0.89	0.21	0.04	0.74	3.85	Trace	3.80
24-6	59.58	23.75	4.90	0.42	0.44	0.69	0.98	4.45	0.05	3.10
25-6	63.30	18.10	6.75	0.64	2.65	1.11	3.25	1.20	0.22	2.06
26-6	64.40	18.85	7.10	0.70	0.34	0.80	0.61	2.62	0.10	2.80
12-7	57.42	23.95	8.50	0.83	0.22	0.19	0.50	4.40	Trace	2.73
13-7	53.12	26.15	9.70	0.90	0.37	0.33	0.74	6.80	Trace	3.22
14-7	63.10	20.30	11.22	0.90	0.15	0.53	0.30	2.90	Trace	2.32

FORM 407

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881

PITTSBURGH, PA.

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ORDER No. SF 657 LABORATORY No.

CLIENT'S No. FILE No.

REPORT

October 16,1953 Page 3

Coranda Corporation
386 Race Street
San Jose , California.
Attention: Mr. J.H. Rodda, President

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	MnO	Ignition Loss
16-7	56.46%	21.05%	14.50%	0.92%	0.47%	1.21%	0.33%	3.05%	0.04%	3.82%
18-7	59.04	26.80	4.25	0.53	0.09	0.46	0.67	6.10	Trace	3.90
21-7	62.12	24.60	5.20	0.74	0.17	0.47	0.63	4.45	0.02	3.13
24-7	57.10	19.45	16.25	1.02	0.51	0.74	0.39	3.45	0.02	2.52
25-7	53.00	24.10	13.70	0.98	0.49	0.36	0.64	4.30	0.01	2.70
26-7	52.02	23.40	14.50	1.07	0.78	0.23	0.73	5.65	0.01	3.08
27-7	43.32	33.40	7.70	0.54	0.48	0.18	1.15	9.30	Trace	2.10

Respectfully submitted,

PITTSBURGH TESTING LABORATORY

Parker M. Robinson

District Manager

SS
wh
cc: 16 Above

FORM 407

PITTSBURGH TESTING LABORATORY

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PITTSBURGH, PA.

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ORDER No. SF 657 651 Howard St. San Francisco LABORATORY No.

CLIENT'S No. FILE No.

REPORT

October 23,1953

Coranda Corporation
386 Race Street
San Jose, California.

Attention:Mr. J.H. Rodda, President

Subject: Pyrometric Cone Equivalents

Composite Number	Sample Numbers	P.C.E No.	Composite Number	Sample Numbers	P.C.E No.
1-1-Comp.	1-1 2-1 3-1 4-1 5-1	16	4-2-Comp.	35-2 36-2 37-2 38-2 39-2	20
2-1-Comp.	6-1 7-1 8-1 9-1 10-1	17	1-3-Comp.	1-3 2-3 3-3 4-3	19
3-1-Comp.	11-1 12-1 15-1 16-1	18	2-3-Comp.	14-3 15-3 16-3 17-3 18-3	17
4-1-Comp.	17-1 18-1 19-1 20-1	18	1-4-Comp.	2-4 3-4 4-4 5-4	18
1-2-Comp.	10-2 11-2 18-2 19-2	16	2-4-Comp.	18-4 19-4 20-4 21-4	20
2-2-Comp.	20-2 21-2 24-2 26-2	19	1-5-Comp.	1-5 3-5 4-5 5-5 5-5-A	28
3-2-Comp.	27-2 31-2 33-2 34-2	20	2-5-Comp.	5-5-B 5-5-C 5-5-D 5-5-E 5-5-F	29

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ORDER No. SF 657 651 Howard ST. San Francisco LABORATORY No.

CLIENT'S No. FILE No.

REPORT

October 23,1953 PAGE 2

Coranda Corporation
386 Race Street
San Jose, California.

Attention:Mr.J.H. Rorda,President

Composite Number	Sample Numbers	P.C.E No.	Composite Number	Sample Numbers	P.C.E No.
3-5-Comp.	7-5 8-5 9-5 10-5 11-5	19	3-6-Comp.	11-6 12-6 13-6 14-6 15-6	28
4-5-Comp.	13-5 14-5 21-5 22-5	20	4-6-Comp.	16-6 17-6 18-6 19-6	31
5-5-Comp.	23-5 24-5 25-5 26-5 27-5	18	5-6-Comp.	20-6 21-6 27-6 28-6	20
6-5-Comp.	28-5 29-5 30-5 31-5 32-5	19	1-7-Comp.	6-7 7-7 8-7 9-7 10-7	15
1-6-Comp.	2-6 3-6 4-6 4-6-A 5-6	23	2-7-Comp.	11-7 12-7 13-7 14-7 15-7 16-7	15
2-6-Comp.	6-6 7-6 8-6 9-6 10-6	20	3-7-Comp.	17-7 18-7 21-7 22-7 23-7	19

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PITTSBURGH TESTING LABORATORY

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ORDER No. SF657

LABORATORY No.

651 Howard St. San Francisco

CLIENT'S No.

FILE No.

REPORT

October 23,1953

Coranda Corporation
386 Ruce Street
San Jose, California.

Attention:Mr. J.H. Rodda,President

Composite Number	Sample Numbers	P.C.E. No.	Composite Number	Sample Numbers	P.C.E No.
4-7-Comp.	24-7 25-7 26-7 27-7 28-7	17	2-2-Comp.-B	B-15-2 B-16-2 B-17-2 B-18-2	20
1-1-Comp.-B	B-1-1 B-2-1 B-3-1 B-4-1	15	3-2-Comp.-B	B-19-2 B-20-2 B-21-2 B-22-2	19
2-1-Comp.-B	B-5-1 B-6-1 B-7-1 B-8-1	15	1-3-Comp.-B	B-8-3 B-9-3 B-10-3 B-11-3	16
3-1-Comp.-B	B-9-1 B-11-1 B-13-1 B-15-1	23	2-3-Comp.-B	B-12-3 B-13-3 B-14-3 B-15-3	18
4-1-Comp.-B	B-16-1 B-17-1 B-18-1 B-19-1	16	3-3-Comp.-B	B-16-3 B-17-3 B-18-3 B-19-3	16
5-1-Comp.-B	B-20-1 B-21-1 B-22-1	17	1-4-Comp.-B	B-1-4 B-2-4 B-3-4 B-4-4 B-5-4	18
1-2-Comp.-B	B-4-2 B-5-2 B-6-2 B-7-2	18			

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ORDER No. SF 657 LABORATORY No.

651 Howard St. San Francisco

CLIENT'S No. FILE No.

REPORT

October 23,1953 PAGE 4

Coranda Corporation
386 Race Street
San Jose,California.

Attention: Mr. J.L.Rodda, President

Composite Number	Sample Numbers	P.C.E. No.	Composite Number	Sample Numbers	P.C.E No.
2-4-Comp.-B	B-6-4 B-7-4 B-8-4 B-9-4 B-10-4	17	1-5-Comp.-B	B-1-5 B-8-5 B-14-5 B-15-5	23
3-4-Comp.-B	B-11-4 B-12-4 B-13-4 B-14-4 B-15-4	16	2-5-Comp.-B	B-16-5 B-17-5 B-18-5 B-19-5 B-20-5	23
4-4-Comp.-B	B-16-4 B-17-4 B-18-4 B-19-4 B-20-4	15			
5-4-Comp.-B	B-21-4 B-22-4 B-23-4 B-24-4	15			
Single Sample Numbers:					
6-4-P-B	L-343-1	37-38			
4-2-P-B	L-343-2	38			
3-4-P	18-4	33			
7-5-P	4-5	33			
6-6-P	20-6	32			

Respectfully submitted,

PITTSBURGH TESTING LABORATORY

Carlos M. Robinson

District Manager

SS:wh
cc: 10 Above

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PITTSBURGH TESTING LABORATORY

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ORDER No. SF 657 651 Howard St. San Francisco LABORATORY No.

CLIENT'S No. FILE No.

REPORT

September 28, 1953

Coranda Corporation
386 Race Street
San Jose, California

Attention: Mr. J. H. Rodda, President

Subject: Four (4) Pyrometric Cone Tests

Sample	P.C.E.
L-343-1	37-38
L-343-1 Calcined	37-38
L-343-2	38
L-343-2 Calcined	38

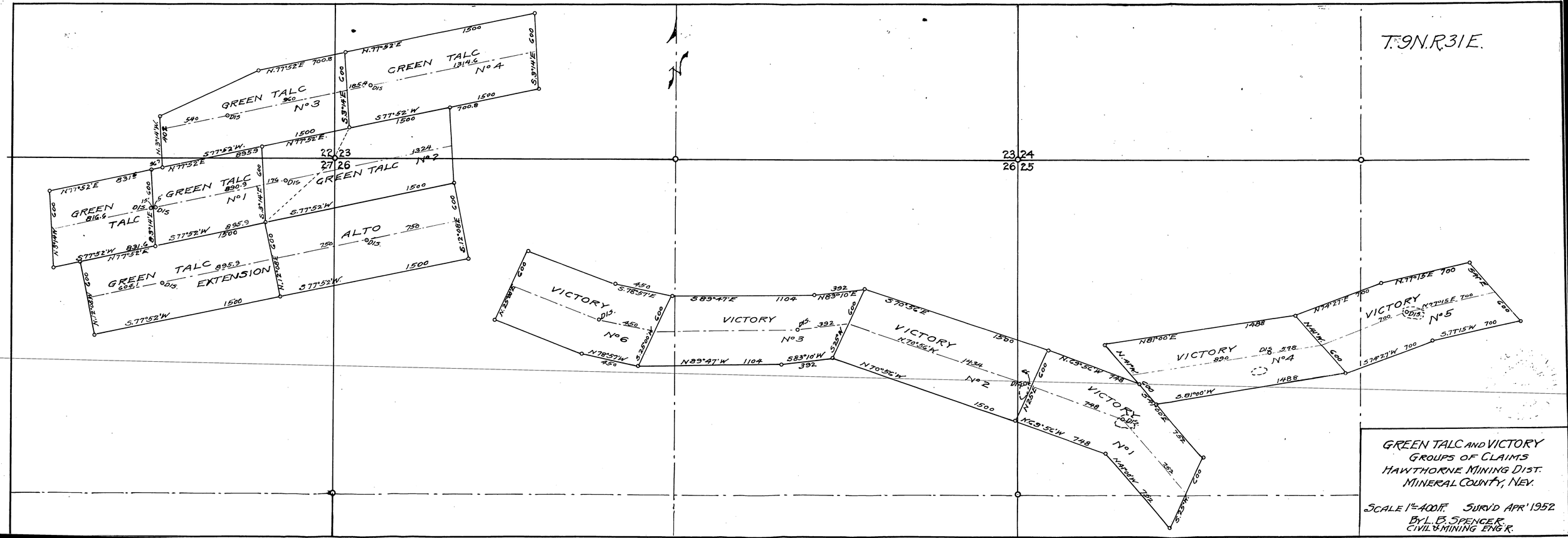
Respectfully submitted,

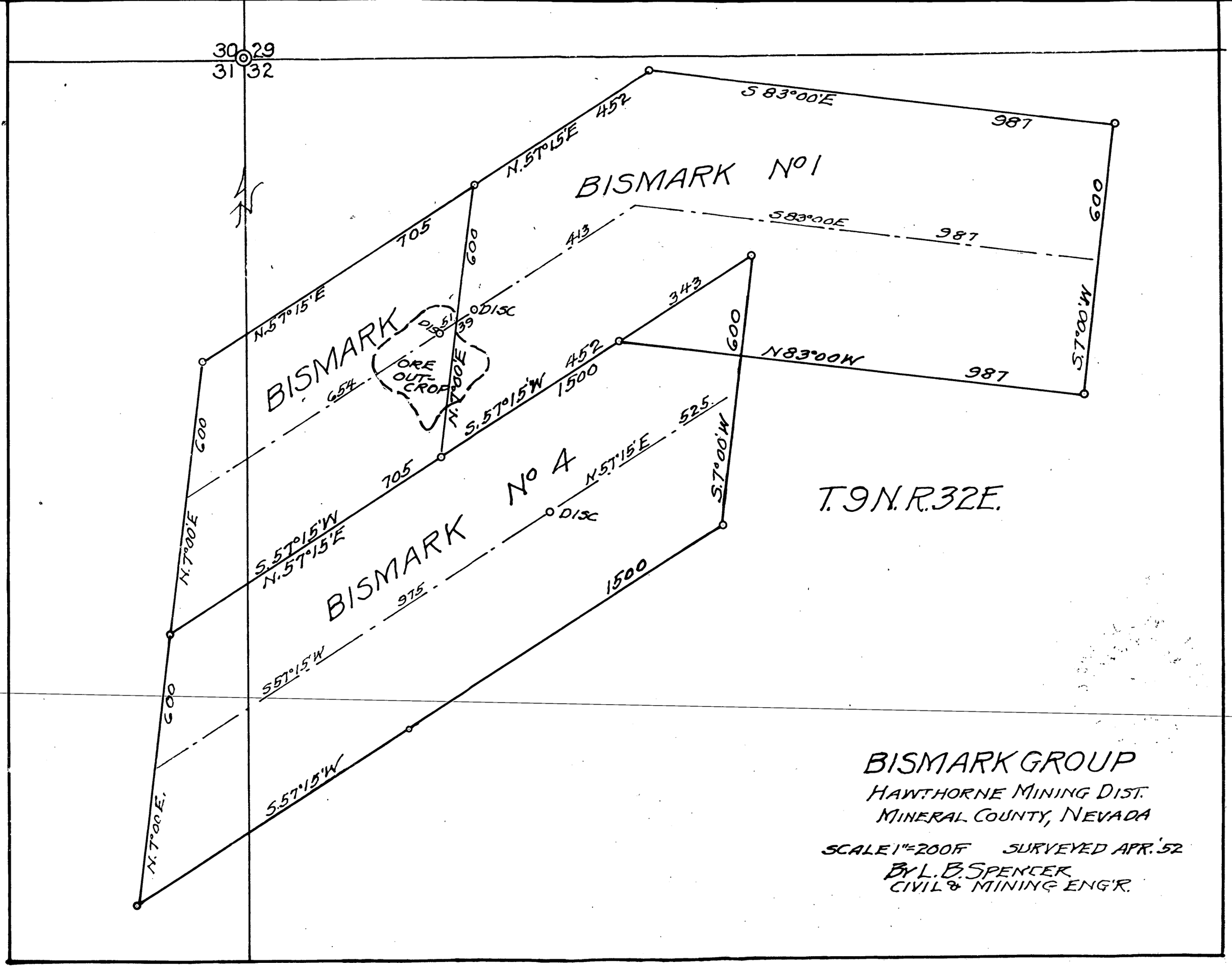
PITTSBURGH TESTING LABORATORY

Parker M. Robinson

District Manager

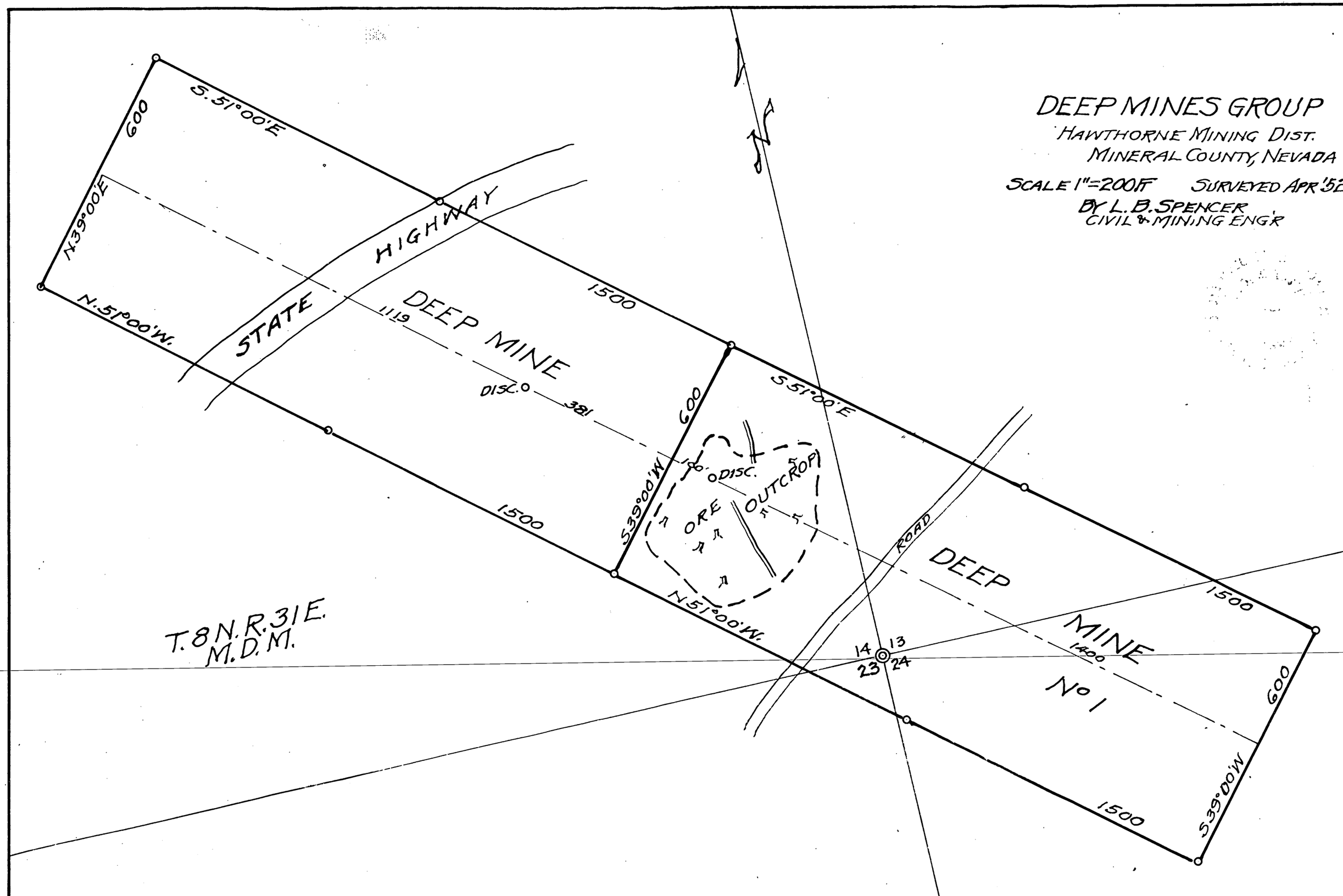
WWC
SS
bk
cc: 10 - above

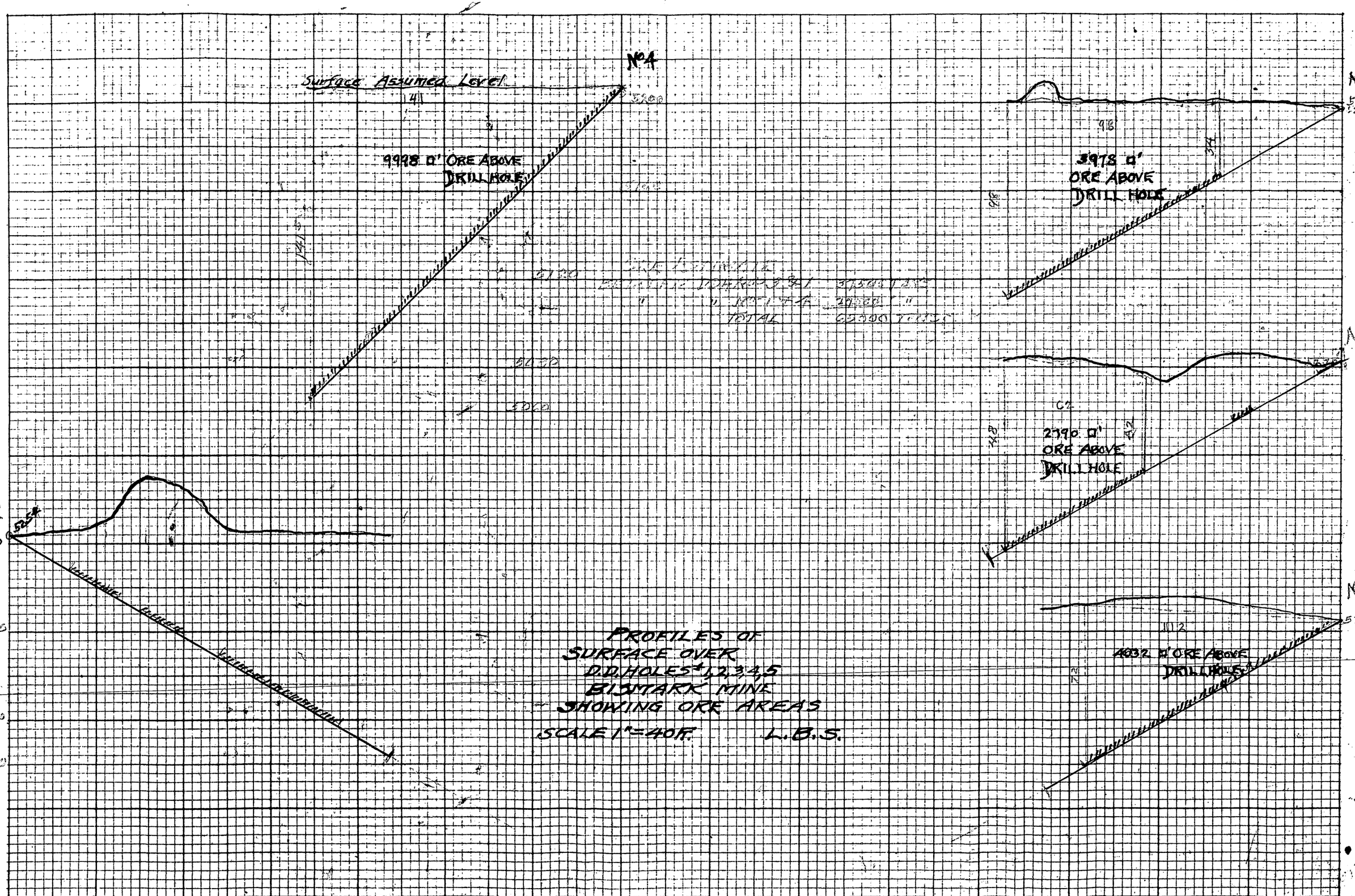

T.9N.R.31E.
GREEN TALC
Nº 4
GREEN TALC
Nº 3
GREEN TALC
Nº 2
GREEN TALC
Nº 1
GREEN TALC
GREEN TALC
EXTENSION
ALTO
VICTORY
Nº 6
VICTORY
Nº 3
VICTORY
Nº 2
VICTORY
Nº 1
VICTORY
Nº 4
VICTORY
Nº 5
22 23
27 26
23 24
26 25
GREEN TALC AND VICTORY
GROUPS OF CLAIMS
HAWTHORNE MINING DIST.
MINERAL COUNTY, NEV.
SCALE 1" = 400 FT. SURV'D APR' 1952
BY L. B. SPENCER.
CIVIL & MINING ENG'R.



BISMARK GROUP
HAWTHORNE MINING DIST.
MINERAL COUNTY, NEVADA

SCALE 1"=200FT SURVEYED APR. '52
BY L. B. SPENCER
CIVIL & MINING ENG'R.


DEEP MINES GROUP
HAWTHORNE MINING DIST.
MINERAL COUNTY, NEVADA
SCALE 1"=200FT SURVEYED APR '52
BY L. B. SPENCER
CIVIL & MINING ENG'R
N
S.51°00'E
600
N39°00'E
N.51°00'W.
STATE
HIGHWAY
DEEP MINE
1119
DISC.
381
1500
600
S.51°00'E
S39°00'W
DISC.
ORE
OUTCROP
ROAD
N.51°00'W.
1500
DEEP
MINE
No 1
1400
1500
600
S39°00'W
1500
14
13
23
24
T.8N.R.31E.
M.D.M.



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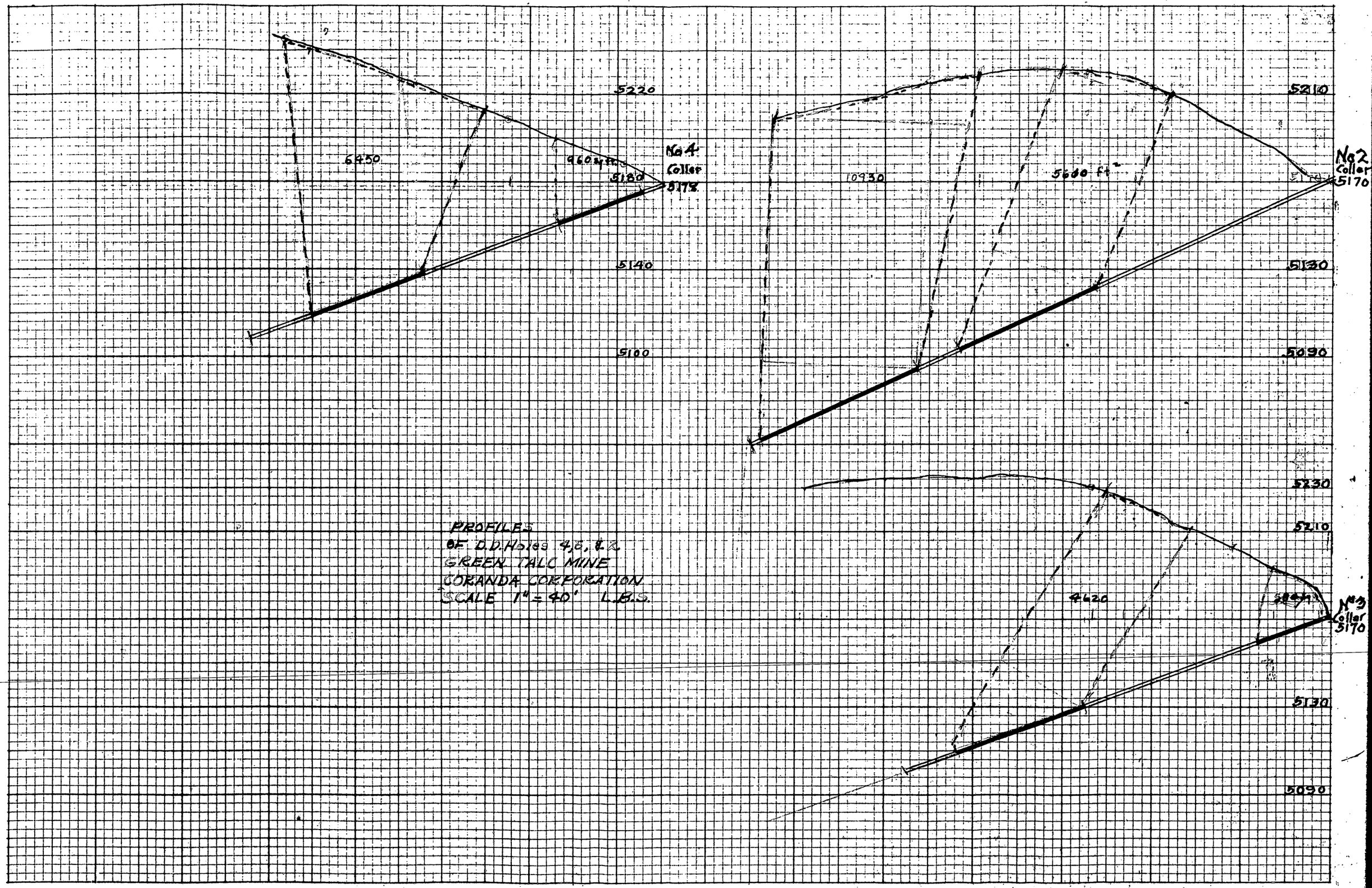
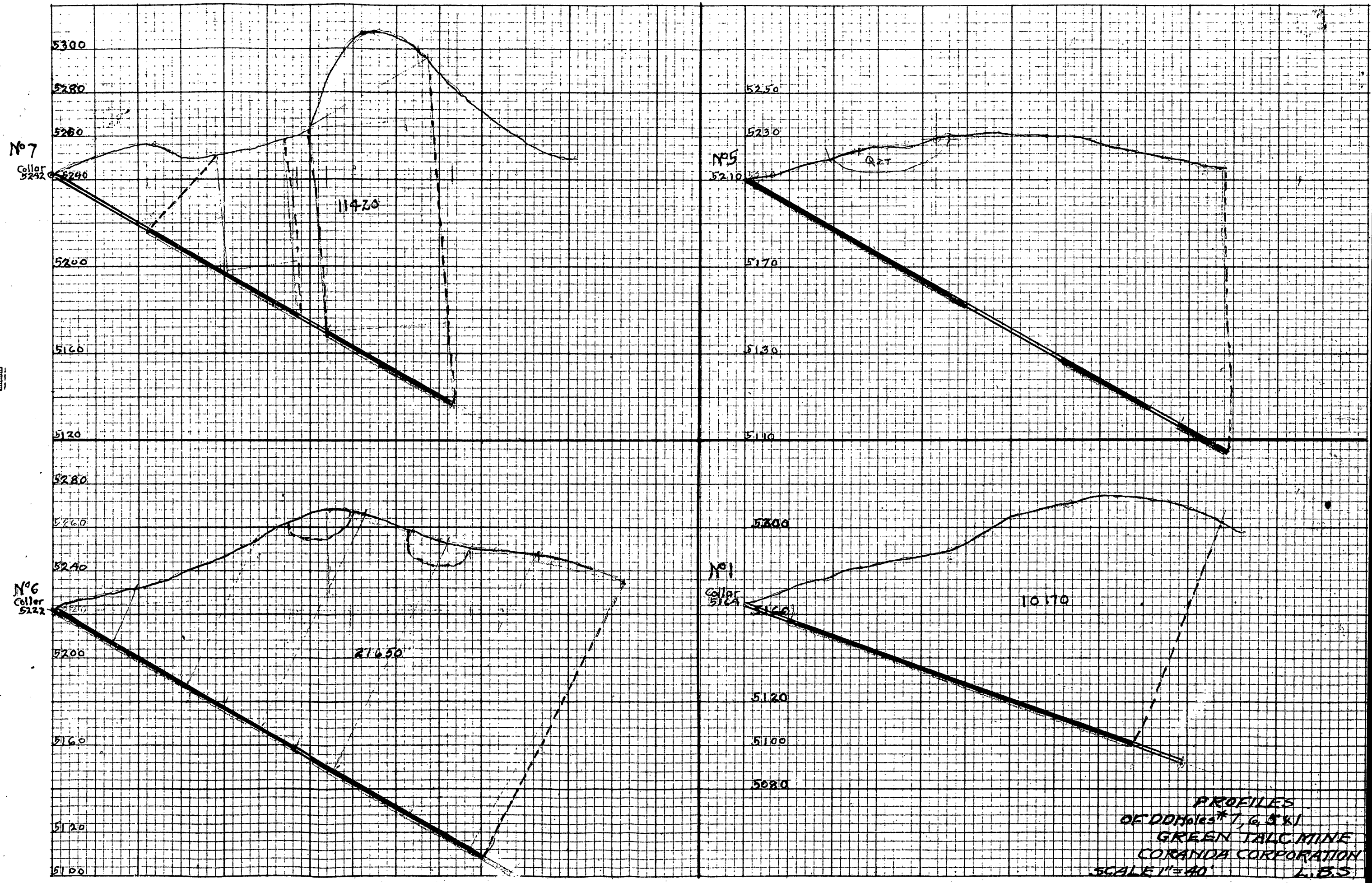

5220
5180
5140
5100
6450
960 ft.
No 4
Collar
5178
5210
5130
5090
10930
5660 ft
No 2
Collar
5170
5230
5210
5130
5090
4420
No 3
Collar
5170
PROFILES
OF D.D.Holes 4,3, & 2
GREEN TALC MINE
CORANDA CORPORATION
SCALE 1" = 40' L.B.S.



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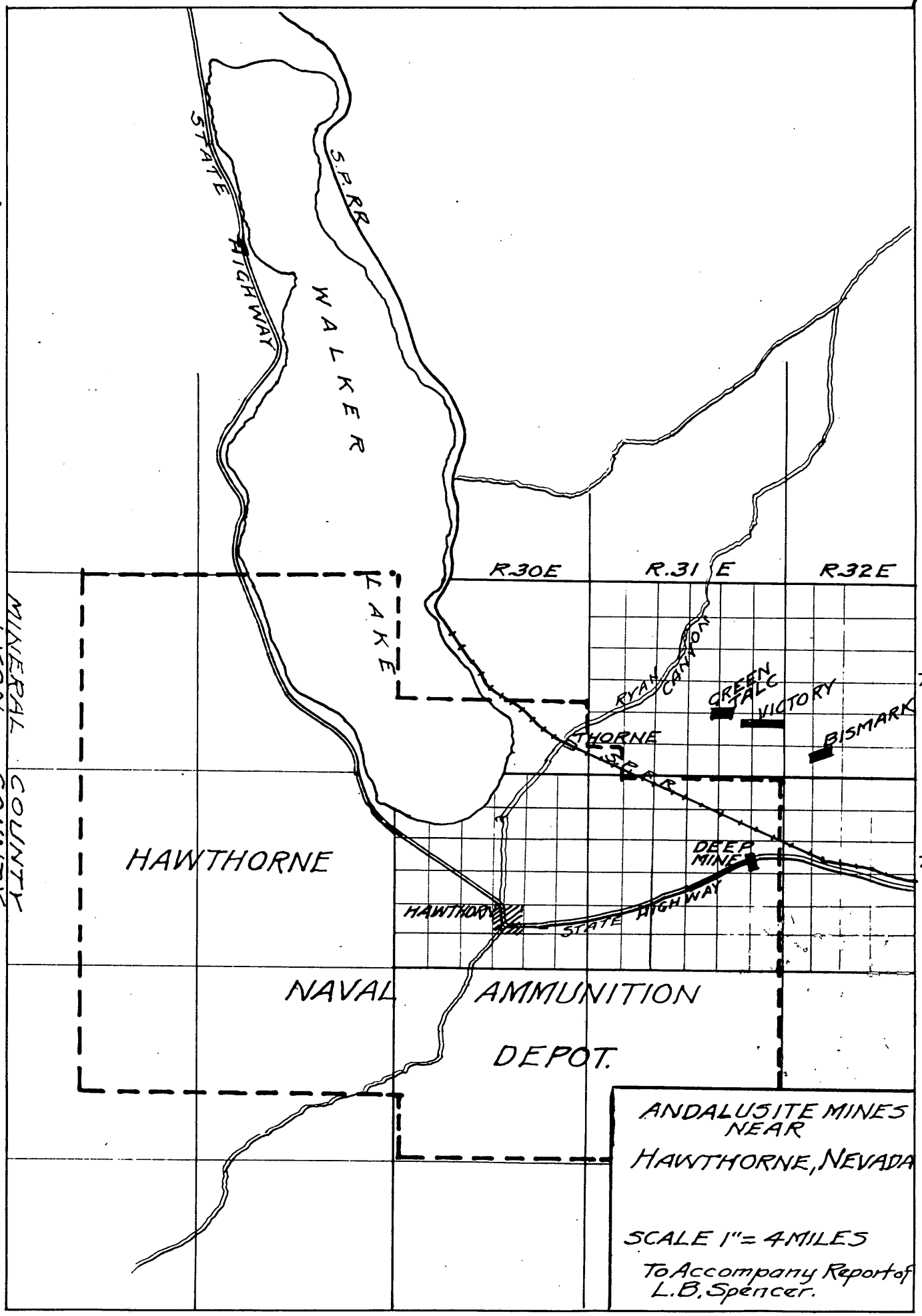
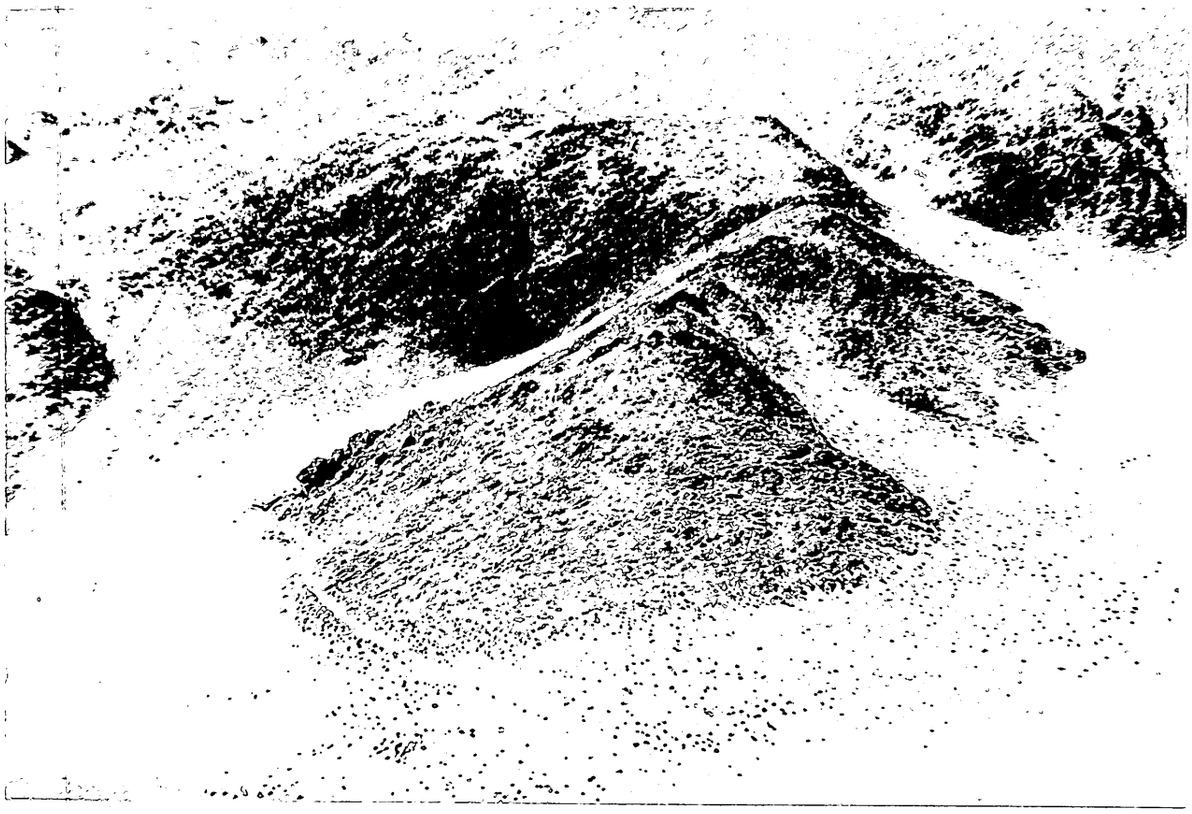


ANDALUSITE MINES NEAR HAWTHORNE, NEVADA

SCALE 1" = 4 MILES

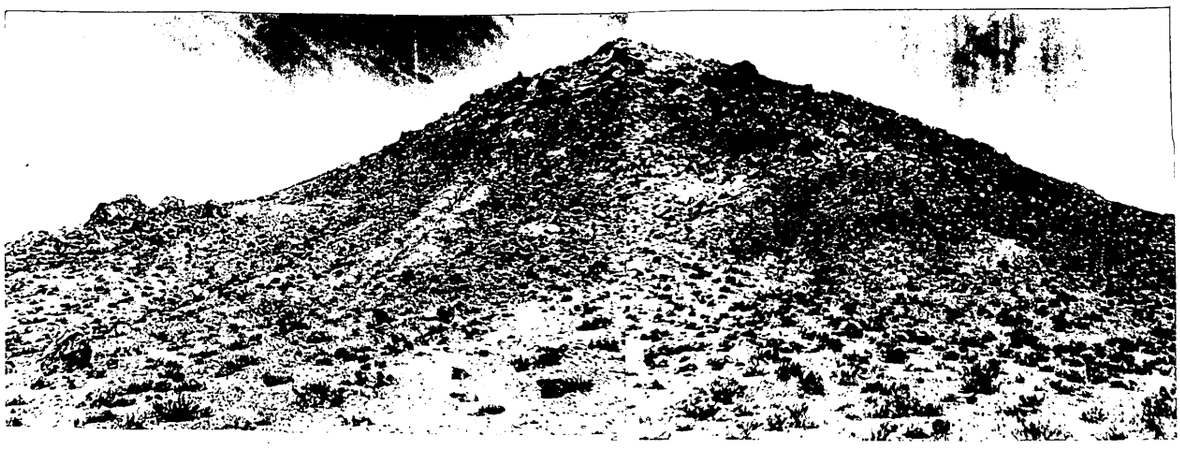
To Accompany Report of L.B. Spencer.



1. Looking to North West on Bismark Claims. Outcrop in picture 2 shows at end of road to left of central hill. White spot on top of hill part of ore bearing structure strike extends left to right over hill.

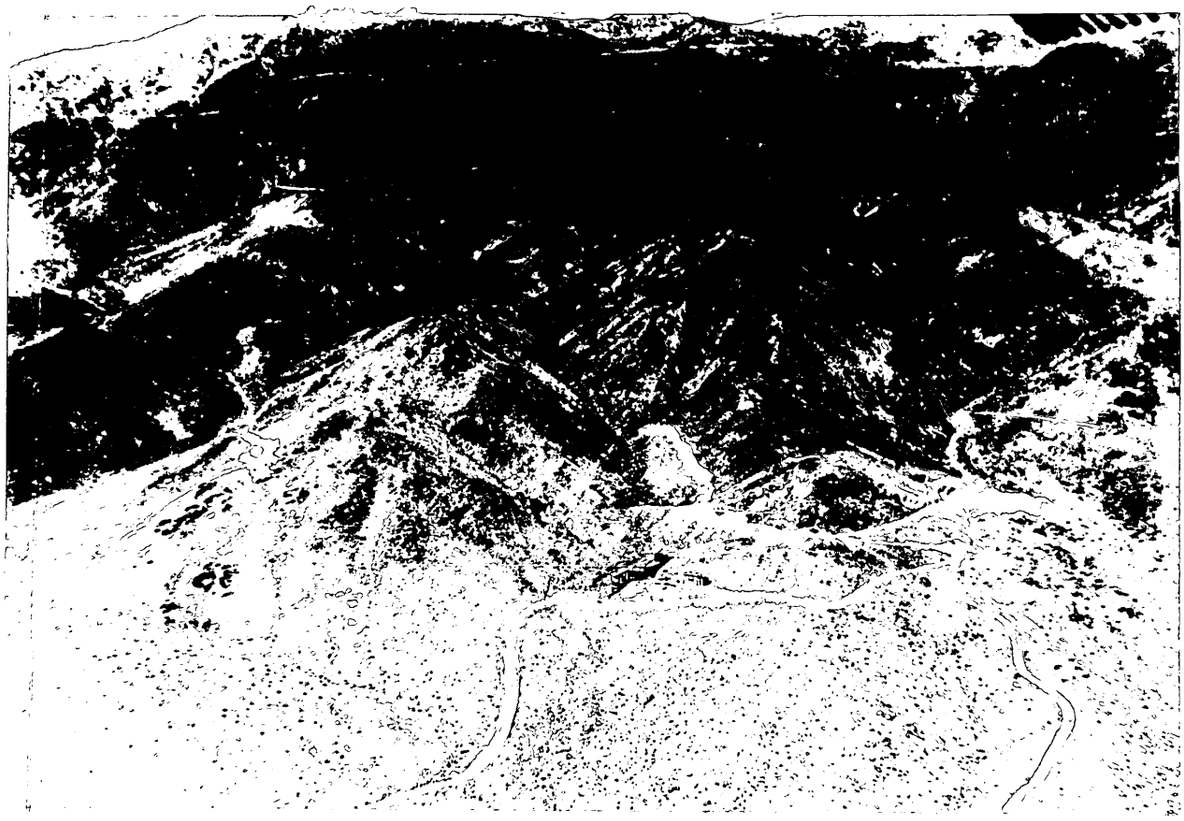
2. Outcrop on Bismark Claim Group looking East along strike of structure.

3. Extension of geologic structure to West on the Bismark Claims.



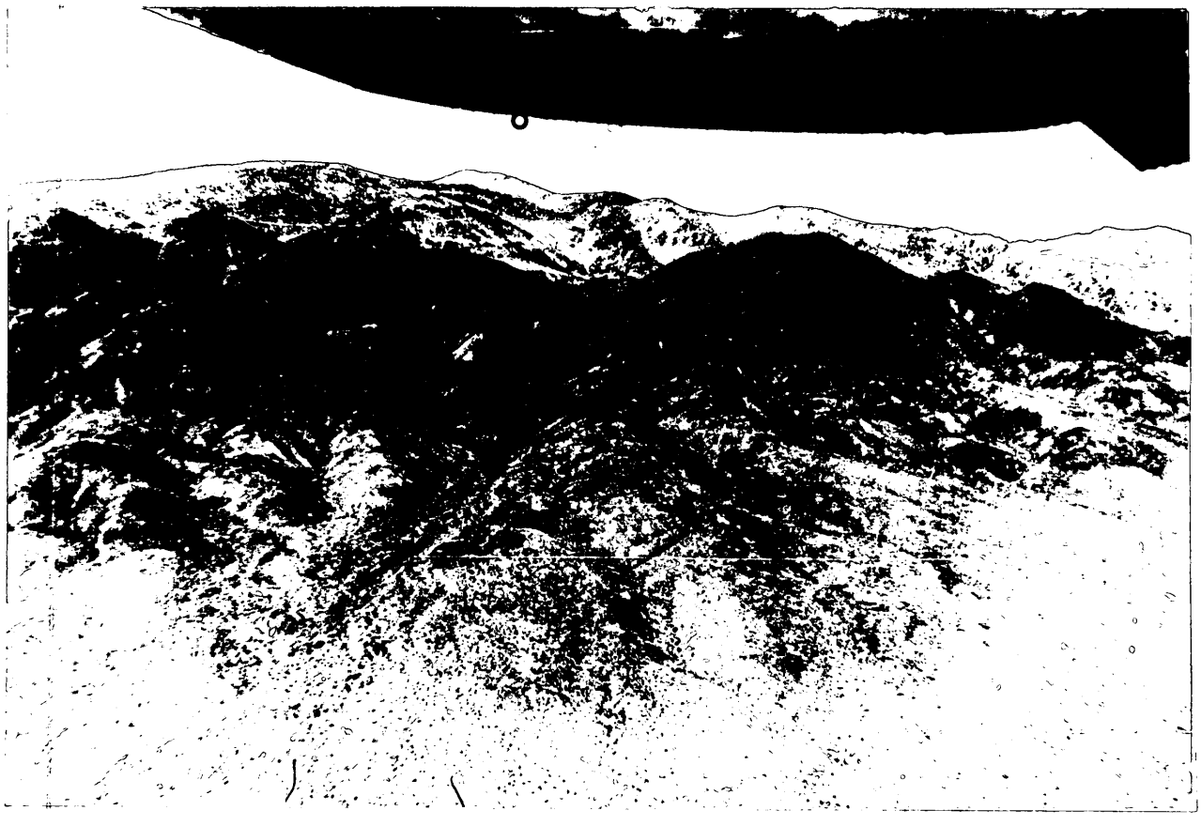
4. Panorama of Deep Mine outcrops looking North. Starting at the left working, the upper limit of the ore zone extends through the lower third of the vertical trench and rises to the upper right working and curves upward to the dark patch of rocks near the top right of the hill. It is reported that the ore zone extends beyond the lower limits

5. Crest of hill on Deep Mine Claims part of this outcrop contains ore.



6. Green Tale Claims looking North, open cut in Picture 7 to the right over buildings.

7. Open cut on Groom F. 1c Claims showing typical ore contacts.



8. General view looking North on Victory Claims.

UNITED STATES DEPARTMENT OF THE INTERIOR
H. L. Ickes, Secretary

BUREAU OF MINES
R. R. Sayers, Director

War Minerals Report 388

PRELIMINARY PILOT-PLANT CONCENTRATION OF ANDALUSITE-CORUNDUM ORE FROM THE VICINITY OF HAWTHORNE, NEV.

WASHINGTON: 1945

This report is intended for limited distribution among officials of the United States Government. The information contained therein should not be made available to unauthorized persons.

The War Minerals Reports of the Bureau of Mines are issued by the United States Department of the Interior to give official expression to the conclusions reached on various investigations relating to domestic minerals. These reports are based upon the field work of the Bureau of Mines and upon data made available to the Department from other sources. The primary purpose of these reports is to provide essential information to the war agencies of the United States Government and to assist owners and operators of mining properties in the production of minerals vital to the prosecution of the war.

Andalusite Al_2SiO_5
Sillimanite Al_2SiO_5
Kyanite Al_2SiO_5

WAR MINERALS REPORT

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

W.M.R. 388 — Andalusite-corundum ore May 1945

Corundum Al_2O_3
Mullite $3Al_2O_3 \cdot 2SiO_2$

PRELIMINARY PILOT-PLANT CONCENTRATION OF ANDALUSITE-CORUNDUM ORE FROM THE VICINITY OF HAWTHORNE, NEV.[1]

SUMMARY

The far-western area of the United States has relatively few developed deposits of minerals containing enough alumina to be used for the manufacture of high-alumina furnace refractories. The andalusite ore in the Hawthorne deposit is not sufficiently uniform to meet market specifications for refractory purposes, but it is possible that the ore may be beneficiated so as to produce a satisfactory concentrate. Preliminary tests have indicated that gravity concentration would produce the highest-grade product and would represent the simplest method of treatment.

Pilot-plant tabling tests were made on about 50 tons of ore that analyzed 42.5 percent Al_2O_3 and 54.2 percent SiO_2. Three flow sheets were used, each varying slightly in grinding and sizing procedure; 15 different concentrates were produced, which varied in grade from 52.1 to 72.4 percent Al_2O_3 and 44.9 to 25.2 percent SiO_2, the composited average being 62.3 percent Al_2O_3 and 35.1 percent SiO_2; the over-all ratio of concentration was 4.2 to 1. One special corundum concentrate containing 91.5 percent Al_2O_3 was made in addition.

The final value of the concentrates to the refractory industry will be determined by further large-scale tests conducted cooperatively by Pacific-coast refractory producers who will mix the concentrate with clay in an attempt to produce a super-duty fire brick.

INTRODUCTION

Modern industry steadily is increasing its demands for furnace refractories that possess a combination of high mechanical strength, low porosity and shrinkage, and resistance to abrasion at high temperatures. In many instances these demands have been fulfilled best by high-alumina refractories composed predominantly of the artificial mineral compound mullite, $3Al_2O_3 \cdot 2SiO_2$. Mullite is a product formed by the interaction of

1 By C. T. Baroch, ass't. supervising engineer; H. D. Snedden and V. E. Homme, associate metallurgists; and E. T. Schrenk, assistant mineralogist, Bureau of Mines.

silica and alumina in correct proportions at relatively high firing temperatures or may be obtained as a transition product of the decomposition of minerals of the kyanite group (andalusite, kyanite, and sillimanite) at high temperatures.

High-alumina refractories are neutral, and they flux or form slags with difficulty; consequently, they are used widely in lead and glass furnaces, clinker-zone linings in Portland cement kilns, in boiler-furnace settings used for high-ash coals, and in blast-furnace regenerators. A list of pyrometric cone equivalent values and chemical analyses of various grades of typical high-alumina brick are given in table 1.[2]

TABLE 1. - Typical analyses of high-alumina refractories

High alumina, class	Analysis, percent			
	50	60	70	80
Al_2O_3	51.5	60.8	70.6	79.4
SiO_2	41.9	33.3	22.8	15.8
TiO_2	2.7	3.0	3.7	2.1
Fe_2O_3	1.8	1.7	1.8	1.7
CaO	.1	.2	.2	.2
MgO	.5	.3	.3	.3
Alkalies	1.2	1.1	1.0	1.0
P.C.E., cone number	34-35	36-37	38	39
Temperature equivalent, °C.	1,773	1,815	1,835	1,865

Specifications for marketable andalusite require a product containing 60 to 65 percent Al_2O_3; it is sold frequently on the basis of a specific gravity ranging between 3.05 and 3.15. The Hawthorne deposits are not directly marketable as an andalusite of refractory grade, because most of the ore contains only 40 to 50 percent Al_2O_3.

Preliminary concentration tests made at the ore-testing laboratories of the Bureau of Mines, Salt Lake City, Utah, early in 1943 included gravity separation by "sink-float;" jigging and tabling methods on minus 1/2-inch, 3-mesh, and 35-mesh ore; electrostatic and electromagnetic separation on gravity separation products; and flotation with fatty acids, cationic reagents, and alcohols at high, intermediate, and low pH values.

Conclusions reached by the laboratory work showed that Hawthorne andalusite ore could be beneficiated as follows:

1. By table concentration of ore ground to minus 48-mesh and sized; 66.0 percent of the alumina was recovered in a product containing 63.2 percent Al_2O_3 and 35.8 percent SiO_2.

2. By cationic flotation of silica from ore ground to minus 100-mesh; 71.3 percent of the alumina was recovered in a product containing 60.0 percent Al_2O_3 and 39.4 percent SiO_2.

3. By fatty-acid flotation of ore ground to minus 100-mesh; 54.7 percent of the alumina was recovered in a product containing 60.7 percent Al_2O_3 and 37.8 percent SiO_2.

2 Rochow, W. R., Properties and Applications of Modern Refractories: Chem. and Met. Eng., vol. 42, 1935, p. 76.

Gravity concentration gave the highest-grade product and represents the simplest method of treatment; therefore, it appears to be the preferable method.

The value of clays and other minerals for refractory purposes can not be determined solely by chemical analyses, as many physical attributes of the materials and variations of processing techniques enter into the quality of a refractory. Consequently, it became apparent early in the investigation that the ultimate use-value of Hawthorne concentrates could be determined only by trial firings. This meant that a sizable quantity of concentrates would be required; therefore, 59 tons of the ore was shipped to the Boulder City, Nev., pilot plant. This ore was treated by table concentration, and concentrates were made in small lots of different grades and particle sizes for subsequent use in refractory firing tests. The refractory test work probably will be performed partly under cooperative agreements with Pacific-coast refractory manufacturers and partly by Bureau of Mines specialists in nonmetallic minerals.

DESCRIPTION OF THE ORE

The ore deposits are in the southern foothills of the Gillis Range about 10 miles northeast of Hawthorne, Mineral County, Nev. The Federal Geological Survey reports five groups of claims in the district. They are the Green Talc, Dover, Bismarck, Victory, and Deep Mines. The Bureau of Mines has made ore-dressing tests on samples from two of the groups - the Green Talc, controlled by William Rae and John Buich, and the Dover, controlled by B. H. Donnelly and associates. The original (Eriksen) sample tested by the Bureau of Mines is reported by Donnelly to be from his property. The sample treated in the Boulder City pilot mill was taken from the Green Talc group of claims.

Reserves

Little developing has been done, and no mineral reserve has been technically blocked in any of the deposits. Tonnage estimates of inferred mineral are based upon surface outcrops assumed to extend to a depth of 100 feet.

Green Talc group. - The main outcrop is approximately 800 by 200 feet in surface area. If assumed to extend to 100 feet in depth and to be of milling grade, 1,300,000 tons of inferred material is indicated.

Dover group. - No tonnage estimates can be made of mineral in this group because of surface overburden and insufficient development.

Deep Mines group. - Andalusite and associated aluminum silicate minerals outcrop over an area 300 by 300 feet. If mineralization is assumed to extend for a depth of 100 feet, 750,000 tons of milling-grade material may exist.

Victory group. - No mineral other than float has been found on this group. It was located recently and no work has yet been done.

Bismarck group. - Aluminum silicate minerals outcrop over an area 50 by 150 feet. If this deposit is assumed to extend to a depth of 100 feet, 62,500 tons of milling-grade minerals might be produced.

Estimated inferred mineral

	Tons
Green Talc group	1,300,000
Deep Mines group	750,000
Bismarck group	62,500
	2,112,500
Less 40 percent estimated for inclusions of dikes, quartzite, and submarginal material	845,000
Net	1,267,500

Submarginal mineral is that having a specific gravity less than 2.9.

The 59 tons of ore received for the test arrived in two truck-and-trailer shipments. The ore of the first truckload was characterized by large, conspicuous masses and veins of green sericite; the ore in the second shipment carried green sericite in small veins only. In general, the material is fine-grained, dense, and quite hard; it is gray to grayish-blue in color except in the zones or veins, in which the pale-green sericite predominates.

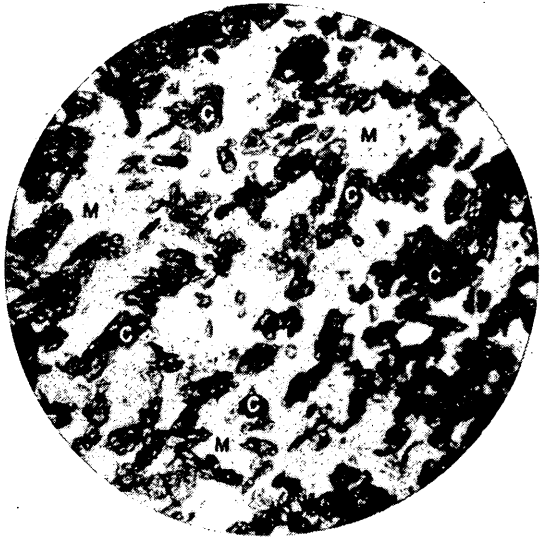
The rock appears to have been formed by contact metamorphism brought about by an igneous intrusion into argillaceous country rock and subsequently altered by hydrothermal action.

The principal minerals identified in thin sections include:

1. Andalusite. - Al_2SiO_5; specific gravity 3.16; hardness 7.5; usually breaks into prisms showing cleavage in one or two directions and an uneven fracture; changes to mullite at about 1,350° C. The andalusite in this ore is pale cream to milky white in color. It occurs chiefly as small crystals and remnants of crystals disseminated throughout the rock or occasionally as coarse crystals concentrated in short, thick, lenslike masses. In addition, all of the pale-green sericite veinlets examined contain small crystals of andalusite, typically shown in figure 1. Inclusions of sericite are common within individual andalusite crystals, and it appears that much of the original andalusite has been altered to sericite.

2. Corundum. - Al_2O_3; specific gravity 3.95-4.10; hardness 9; usually breaks into grains having irregular cleavage and uneven to conchoidal fracture; melting point, 2,050° C. Most of the corundum in this ore is deep blue in color, but some varies to almost white. It is disseminated throughout the ore, but areas of concentrated granular corundum are not uncommon. The crystals are very small, show inclusions of mica or mica-like minerals, and occur singly or in small clusters typically as shown in figure 2.

1



2

A - andalusite
C - corundum
Q - quartz
M - mica

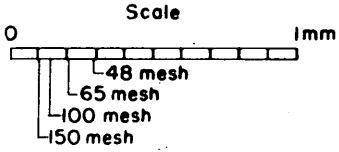


FIGURE 1.- Green sericite veinlet adjacent to andalusite crystals. Polarized light.
FIGURE 2.- Average gray-blue mottled ore. Corundum crystals in a groundmass of sericite. Plane light.

3. Mica. - Variable in composition but essentially acid salts of orthosilicic acid or acid aluminosilicate; specific gravity 2.7; hardness 2-2.25. Muscovite (potassium micas), sericite (fine-grained muscovite), and perhaps some paragonite (sodium mica) are present in the Hawthorne ore. Small books of muscovite were noted, but these are not abundant. However, sericite is abundant and occurs intimately mixed with the andalusite and corundum or independently in pale-green veinlets. Chemical analyses of selected material indicate that if the soda mica, paragonite, $H_2NaAl_3(SiO_4)_3$, is present, it is minor as compared to sericite, and that the sericite is low in potash, as shown in table 2.

TABLE 2. - Chemical analysis of pale-green sericite

	Percent		Percent
Al_2O_3	38.40	MgO	0.65
SiO_2	47.19	CaO	.28
Fe_2O_3	.32	TiO_2	.10
K_2O	8.18	B	.08
Na_2O	.76	L.O.I.	4.32

4. Quartz. - SiO_2; specific gravity, 2.5; hardness, 7. Quartz is present throughout all of this material as very small anhedral crystals or else as small, rounded grains up to 0.2 mm. in diameter. It is most abundant as small anhedral grains associated with the sericite.

5. Pyrophyllite. - $H_2Al_2(SiO_3)_4$; specific gravity, 2.8-9; hardness, 1-2. One mica-like constituent of the ore was identified by X-ray and chemical analyses as pyrophyllite. The chemical and physical similarities of this mineral and mica prevent quantitative determination of either when both are present in an ore.

Several accessory minerals, including titanite, magnetite, and hematite, were noted in the thin sections, but their percentage is small. A chemical analysis of the ore is given in table 3.

TABLE 3. - Chemical analysis of ore

	Percent		Percent
Al_2O_3	42.50	Fe_2O_3	0.42
SiO_2	54.20	TiO_2	.77
K_2O	.73	Fe_m*	.12
Na_2O	.29	L.O.I., 800° C.	2.13

*Metallic iron from grinding.

Mineralogical analyses were made by using two different techniques on representative portions of the ore, the first at the Boulder City station and the second at the Salt Lake station.

The first mineralogical analysis was made by using a combination of heavy-liquid separation and interpretation of chemical analysis. To assure accuracy, several tests were made and each product was examined under

the petrographic microscope. Assuming that quartz, combined silica (mica), corundum, and andalusite are the variables in this ore, the percentage of minerals can be calculated from the chemical analysis if the percentage of corundum is known. Corundum was determined by separation with the heavy liquid methylene iodide, specific gravity 3.325, using a sample ground to pass a 150-mesh screen. The quantity of mica was calculated from the K_2O and Na_2O determined by chemical analysis, but insufficient alkali was present to account for the percentage of micas actually observed with the microscope. It is possible that pyrophyllite, $Al_2O_3 \cdot 4SiO_2 \cdot H_2O$, may be present and that it has been mistaken for sericite, because the optical properties of these two minerals are very similar.[3] If pyrophyllite is present in large amounts correct interpretation of chemical analyses is impossible, because andalusite and pyrophyllite are so closely related chemically and because heavy-liquid separation of pyrophyllite from sericite is not practical. Furthermore, if pyrophyllite is present, the percentage of andalusite and quartz must be reduced. The results of this analysis is given in table 4, column I.

The second mineralogical analysis was made by microscopic grain count on closely sized and carefully split fractions of the ore, using oils of varying refractive indices to distinguish the various minerals. Corundum was the only mineral identified above the index of refraction of 1.7400. The micaceous minerals and quartz were all found to be below the index of refraction of 1.6031, and all the material above this index was considered to be either andalusite or corundum. A microscopic count was then made on the same fractions, using an oil with an index of refraction of 1.7400, and all the material having a higher index was assumed to be corundum. The sample, ground to minus 100-mesh, was sized into eight products by screening and elutriation, and each fraction was weighed. A statistical count of each mineral type was taken on 500 grains in each fraction. The weighted average of the microscopic counts, which represents the volume of the different minerals, was transposed to weight percentage by assuming the gangue to have a specific gravity of 2.8, the andalusite 3.1, and the corundum 3.8. The results are given in table 4, column II.

TABLE 4. - Estimated mineral analysis of heads, specific gravity 2.95

	Weight, percent	
	I	II
Andalusite	30-35	20
Corundum	15-20	20
Mica	20-30	-
Quartz	20-30	-
Titanite	1-2	-
Miscellaneous	5-10	-
Gangue	-	60

3 Rogers and Kerr, Optical Mineralogy, 2d ed.: McGraw-Hill Book Co., Inc., New York, 1942, p. 351.

The two methods of mineralogical analyses check well regarding the amount of corundum present, but the values for andalusite are controversial. The difference in the latter could be accounted for by the presence of pyrophyllite, which has been reported by others as being present in some samples from the Hawthorne deposits. If it was present in the test sample under consideration, it was evidently too fine-grained to be positively identified with the microscope. Other factors affecting the accuracy of any mineralogical analysis include (1) difficulty of identifying submicroscopic particles produced by grinding to obtain liberation, (2) difficulty of identifying various intermediate decomposition products that occur in the ore, (3) difficulty of obtaining a small sample for microscopic analysis that is wholly representative of the ore.

TEST PROCEDURE AND RESULTS

The original laboratory tests indicated that the valuable minerals were free only at sizes finer than 35-mesh; even finer grinding appears to be necessary to free completely the mineral particles in the ore received for the pilot-plant work. The mineral-dressing tests also showed that the determination of the point at which to make cuts on the table between concentrate, middling, and tailing is difficult because there is little difference in the appearance of these products. Some preliminary tests were made on a small laboratory table using ultraviolet light, with and without filters, and various colored and fluorescent lights, but of these, only white fluorescent light intensified the bluish color of the corundum slightly. A pale wine-colored andalusite, sized to the table feed, was added to the feed in one test to determine whether or not this would act as a guide to give a suitable indication where a separating cut might be made; the method is satisfactory, but a large amount of the colored mineral is required.

The ultimate control method adopted consisted of specific-gravity determinations and frequent vanner plaque tests on samples of the table products. The bluish corundum could be distinguished readily on the vanner; its presence could be determined in the tailings and middlings, and the operators soon learned how to appraise the approximate grade of concentrate by the relative amount of the contained blue mineral.

The difference in specific gravity between andalusite, 3.16, and the quartz-mica gangue, 2.6-2.7, is not large, and their gravity separation by tabling requires careful adjustment of feed rate and close sizing of table feed. In the pilot-plant runs, ground ore was hydraulically classified or screen sized, the coarsest fraction tabled directly, and the finer sizes stored in tanks and tabled later. The same table was used for all the classified products. Three flow sheets were used, each varying in the method of preparing and sizing table feed.

First Flow Sheet

The first pilot-mill work was conducted according to the flow sheet shown in figure 3, and a screen analysis of the ball-mill feed is given in table 5.

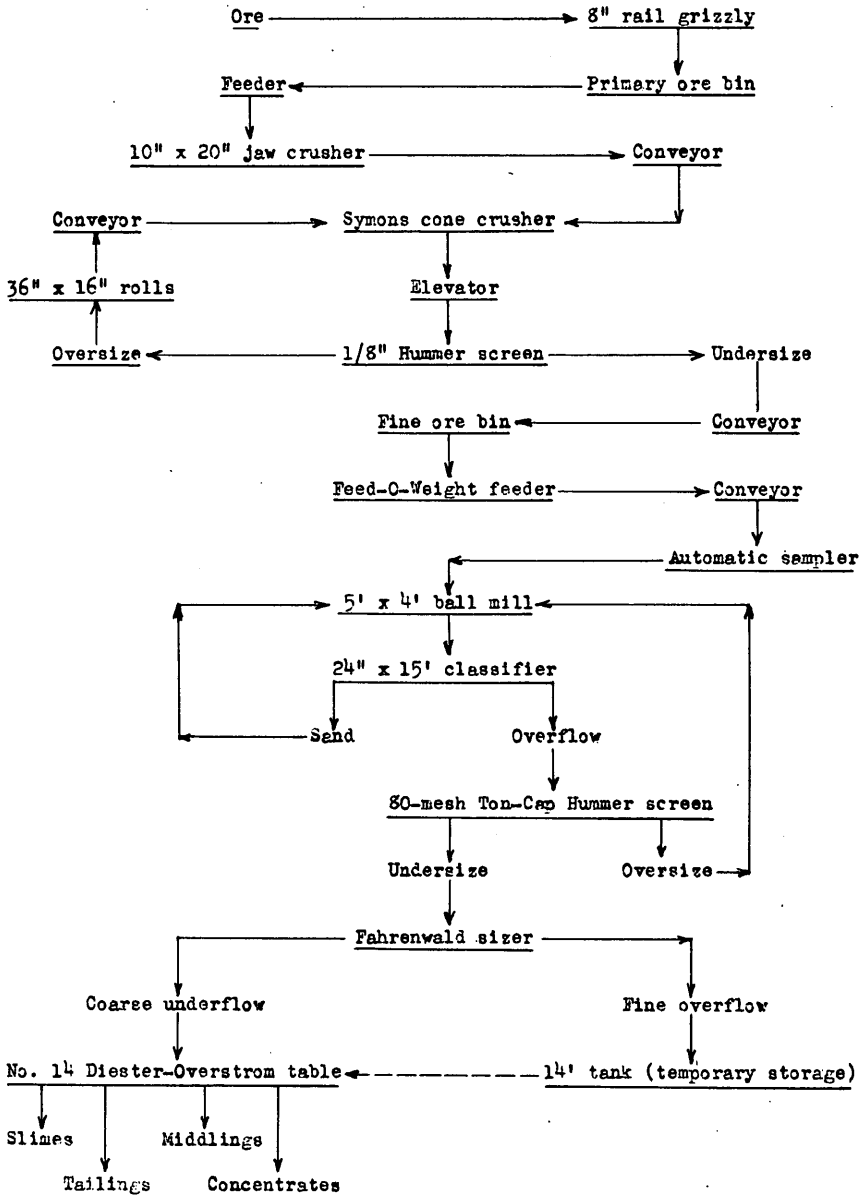


Figure 3. - First flow sheet.

TABLE 5. - Screen analyses of 1/8-inch ball mill feed

Mesh	Weight, percent	Cumulative, percent
-6+8.	15.67	15.67
-8+10	15.54	31.21
-10+14.	16.19	47.40
-14+20.	9.69	57.09
-20+28.	7.08	64.17
-28+35.	5.40	69.57
-35+48.	4.61	74.18
-48+65.	3.32	77.50
-65+100	3.71	81.21
-100+200. . . .	5.46	88.67
-200.	13.33	100.00

Fine ore was fed by means of a Merrick Feed-O-Weight constant-weight feeder, which recorded the weight of the ore. An automatic sampler cut the full stream of ore every 3 minutes. The ball mill, 5 feet in diameter by 4 feet long, was charged with 2,100 pounds of 4-inch balls, 2,250 pounds of 3-inch balls, and 650 pounds of 2-inch balls. The mill operated in closed circuit with a Dorr rake-type classifier 24 inches wide by 15 feet long, the overflow of which was pumped to a Hummer vibrating screen fitted with 80-mesh Ton-Cap sieve wire. Ball-mill feed rate was increased gradually to as high as 2,760 pounds per hour, but this is not the maximum capacity of the mill for this size feed, as very little sand was returned to the mill by the classifier. Pulp discharge from the ball mill contained 50 to 60 percent solids, and the classifier operated at 35 to 40 percent solids.

The original intention was to feed the 80-mesh screen oversize to the table, but flow of this product was too irregular for successful table operation, so the oversize was returned to the ball mill. Screen undersize contained a fair amount of material that was plus 80-mesh and all minus 48-mesh, as measured by standard Tyler sieves. This undersize was pumped to a 6-compartment type C Fahrenwald sizer used as a deslimer rather than as a sizer; overflow from the sizer was stored temporarily in a 14-foot tank, which, in turn, overflowed to a slime thickener and storage tank. The coarse fraction was treated while operating the grinding unit.

Only the cone of the Fahrenwald sizer was used to feed the table. A small amount of hydraulic water added to the cone when operating the grinding circuit removed most of the slime and fines, allowing the coarser particles to be fed to the table with the finer fraction. While tabling the stored overflow material, all of the hydraulic water was turned off, and the sizer was used only as a feeder for the table.

All of the material was tabled on a No. 14 Diester-Overstrom diagonal deck table 4 feet 8-3/4 inches wide at the head-motion end by 8 feet 3-3/4 inches long parallel to the head-motion axis; this table has less than half the area of a standard table with dimensions 6 feet 8-1/2 inches by 14 feet 3 inches. The table was pool-riffled for fine sands or slime separation, the ordinary riffles being 1/8-inch high at the head end by 1/4-inch

wide, every eighth riffle was a pool riffle 1/4-inch high. The table speed was 272 strokes per minute, and the length of stroke ranged from 3/8 to 3/4 inch, the shorter stroke being used on the finer feed. Vanning-plaque tests made in connection with tabling operations, particularly on the finer sizes, indicated that whenever the table was overloaded, fine corundum washed into the slimes and tailings.

A large, white, fluorescent light mounted over the table helped to determine the line of separation between the corundum and middling product, but andalusite was mostly obscured in the middling, and the depth of cut had to be determined by specific-gravity tests. These tests can be made quickly and accurately with the LeChatelier specific-gravity bottle.

To remove grinding iron from the concentrates, a narrow high cut was made on the table. This was treated later with an electromagnet to remove the iron. The remaining fraction, with an average specific gravity of 3.7, analyzed 91.5 percent Al_2O_3 and appeared to be principally corundum.

Six and one-half tons of ore was ground and classified in accordance with the first flow sheet, but the entire circuit was not cleaned out at the end of the run, and some of the finer material and the middling were left over, to be included in subsequent work. This portion of the work was a transitional stage devoted mainly to adapting the results of laboratory test work to large-scale equipment. The grinding procedure of the circuit produced excessive fines, showing that the Hawthorne ore is readily subject to overgrinding; this condition was the paramount reason for the change to the second flow sheet.

Chemical analyses and specific gravities of table products made while producing the second concentrate lot (first flow sheet) are shown in table 6.

TABLE 6. - Chemical analyses and specific gravities of table products, first flow sheet

Material	Specific gravity	Analysis, percent			
		Al_2O_3	SiO_2	Fe_2O_3	TiO_2
Concentrate.	3.28	67.8	28.77	0.85	0.71
Middling	2.97	44.8	49.00	.43	.92
Tailing.	2.85	33.0	57.24	.57	.87
Slime.	2.74	33.1	57.36	2.56	.77

Second Flow Sheet

The second flow sheet was similar to the first, except that a screen with a 1/2-inch opening replaced the 1/8-inch screen in the coarse-crushing section; the rolls were omitted, only the Symons cone crusher being used for secondary crushing, and a 48-mesh Ton-Cap screen replaced the 80-mesh screen used for sizing the ball mill classifier overflow. The screen analysis of table 7 was made on a representative sample of this coarser ore.

TABLE 7. - Analysis of ore crushed through a one-half inch screen

Mesh	Weight, percent	Cumulative, percent
-3/4"+1/2. . . .	4.27	4.27
-1/2"+4.	58.30	62.57
-4+6	7.90	70.47
-6+8	5.70	76.17
-8+10.	4.96	81.13
-10+14	3.23	84.36
-14+20	2.89	87.25
-20+28	2.25	89.50
-28+35	1.90	91.40
-35+48	1.48	92.88
-48+65	1.38	94.26
-65+100.	1.28	95.54
-100+200	1.87	97.51
-200	2.49	100.00

Ball mill feed rate on this coarser material was started at a rate of 2,760 pounds per hour and was increased to the maximum continuous capacity of 3,630 pounds per hour while grinding through the 48-mesh Ton-Cap screen. The ball mill discharge pulp was maintained between 50 and 60 percent solids, which was diluted to give a classifier overflow product of between 40 and 45 percent solids. A screen analysis made on a sample of the 48-mesh Ton-Cap screen undersize is shown in table 8.

The coarser crushing and grinding still tended to create an excessive quantity of fines and slimes. For classifying, the cone of the Fahrenwald sizer was eliminated, and the third compartment was used to feed the table. A sample of the coarse table feed from the sizer, taken at the same time as the preceding screen undersize sample, yielded the screen analysis also shown in table 8. A screen analysis of the sizer overflow is given in the last column of table 8.

TABLE 8. - Screen analysis of 48-mesh screen undersize product and Fahrenwald sizer products

Mesh	Weight, percent		
	Screen undersize	Sizer underflow	Sizer overflow
-20+35. . .	0.61	3.41	-
-35+48. . .	7.40	24.06	-
-48+65. . .	7.56	35.74	0.52
-65+100 . .	13.13	23.51	3.57
-100+200. .	21.07	12.34	42.72
-200. . . .	50.23	.94	53.19

Table capacity of the coarser material was 350 to 450 pounds per hour. The small difference in specific gravity of the minerals prevented them from spreading out over the table, causing the entire table feed to follow along the ends of the riffles and to fan out to about 18 inches at the concentrate end. A narrow band of bluish-gray corundum was visible along the upper edge of the fan. The fine table feed formed a much wider corundum band, which was attributed to better liberation and a smaller amount of middling product. The spread of the fan in this case, virtually covered

the entire concentrate end of the table, reducing the table capacity to 200 or 250 pounds of dry feed per hour. Tilting the table more would wash the concentrates over the tailing side. Most of the slime and coarse mica washed off the head end of the table, regardless of the feed size.

Approximately 33 tons of minus 1/2-inch ore was milled in accordance with flow sheet 2, producing concentrates 3 to 9, inclusive. Inasmuch as 50 percent of the ore was ground to minus 200-mesh in this circuit, it was decided to attempt a lighter grind and a coarser table feed with additional classification before tabling.

Third Flow Sheet

The third flow sheet is outlined in figure 4. The 2,100 pounds of 4-inch balls in the mill were removed and replaced with an equal weight of 1-1/2-inch balls in an effort to reduce over-grinding. The 48-mesh screen receiving the ball mill classifier overflow product was replaced by a 20-mesh screen, and the undersize from this passed to another rake classifier 24 inches wide by 15 feet long. Classifier sand product passed to the Fahrenwald sizer, where two pockets were used to produce two underflow sized products instead of one as in the previous flow sheets. The coarsest sizer product flowed directly to the table, the intermediate product was stored temporarily in a 7-foot tank, and the sizer overflow was combined with the classifier overflow to be stored in the 14-foot tank.

The change in the ball load did not noticeably affect operation of the ball mill; the maximum feed rate remained at 3,630 pounds per hour. Screen analyses of the classifier sand discharge and the three table feed products are shown in table 9.

TABLE 9. - Screen analyses of classifier and Fahrenwald sizer table feed products, flow sheet 3

Mesh	Weight, percent			
	Classifier 2 sand discharge	Fahrenwald sizer products		Classifier and Fahrenwald overflow products
		Coarse	Intermediate	
-20+28 .	6.67	16.74	-	-
-28+35 .	8.05	17.61	1.60	-
-35+48 .	12.76	22.61	6.91	-
-48+65 .	16.88	17.39	14.63	-
-65+100.	21.10	11.96	29.26	-
-100+200	21.49	10.87	43.09	16.87
-200 . .	13.05	2.82	4.51	83.13

Approximately 8 tons of ore was treated by the process shown in the third flow sheet and produced concentrates 10 and 11, the former from the coarse and intermediate sizer products and the latter from the classifier and sizer overflows. The middling from this run was stored separately from the middling products made previously and was tabled again later to produce concentrate 14.

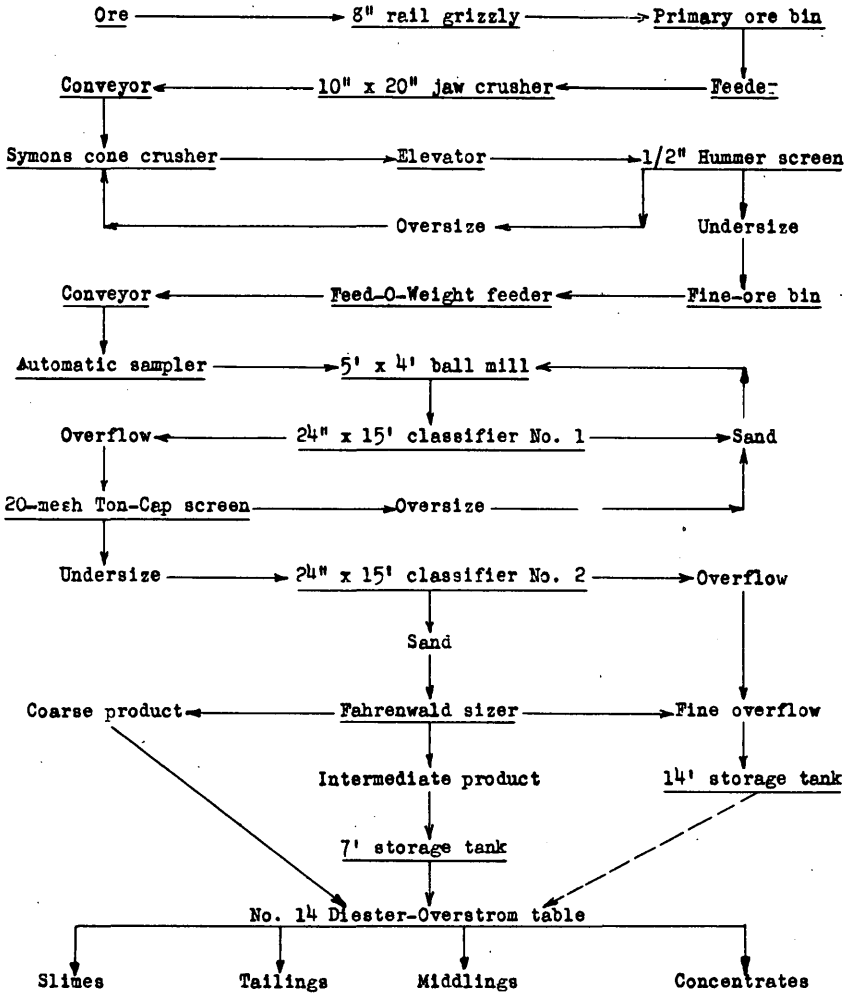


Figure 4. - Third flow sheet

Re-treatment of Middlings

A total of 8.94 tons of various middlings, dry weight, was produced from the 47.5 tons of ore used in the three flow-sheet processes. The middlings contained some free corundum and a fair amount of andalusite, which were recoverable by tabling without regrinding. Partial analyses of the middlings products are given in table 10.

The middlings from the first and second flow-sheet processes were passed over a 100-mesh Hummer screen and separated into a coarse and fine product, each of which was tabled separately to make concentrates 12 and 13, respectively. Middling from the third flow-sheet process was treated separately to produce concentrate 14. The rejected portion of the

middling has been called coarse and fine middling tailing in the summarized data.

TABLE 10. - Analyses of middlings

Number	Percent			
	Al_2O_3	SiO_2	Fe_2O_3	TiO_2
1	44.6	46.5	0.99	0.82
2	44.8	49.0	.43	.92
3	41.3	51.2	.49	.61
4	48.9	45.9	.28	.66
5	51.4	42.1	.28	.77
6	47.7	42.6	.35	.92
7	45.2	46.8	.31	1.17
8	47.9	46.3	.35	.92
9	44.4	49.4	.42	.82
Weighted average	45.3	47.4		

Concentrates and Recovery Data

Weights, particle size, specific gravity, and chemical analyses of all the concentrates are listed in table 11, and the pyrometric cone equivalents for each concentrate are listed in table 12.

The concentrates show a wide range in grade which, excluding the small amount of high-grade corundum recovered as concentrate 16, varied between 52.1 to 72.4 percent Al_2O_3 and 25.2 to 44.9 percent SiO_2. This range of concentrate grade may prove to be valuable, as the main objective of this work was to produce enough high-alumina material so that refractory tests could be made to determine the value of the products.

TABLE 12. - Pyrometric cone equivalents,* andalusite-corundum concentrates

Concentrate	Assay, percent		P. C. E.* No.	Temperature, °C.
	Al_2O_3	SiO_2		
1	62.6	34.5	37+	1,820+
2	60.4	37.6	37+	1,820+
3	60.3	35.9	38-	1,835-
4	67.6	29.3	38	1,835
5	69.2	28.7	39	1,865
6	67.1	28.7	40	1,885
7	66.3	29.5	38+	1,835+
8	72.4	25.2	38	1,835
9	68.0	30.2	40+	1,885+
10	65.4	33.6	38	1,835
11	65.8	32.3	39+	1,865+
12	52.1	44.9	35+	1,785+
13	62.2	35.7	38+	1,835+
14	52.3	44.1	35-	1,835-
15	59.0	39.6	37.5	1,827
16	91.5	5.7	41-	1,970-
Composite	62.3	35.1	38	1,835

*As determined by Northwest Experiment Station, Bureau of Mines, Seattle, Wash.

A large proportion of each concentrate has been shipped to Gladding, McBean & Co. at Pittsburg, Calif., for testing their value as a refractory. Other proportionate parts of the concentrates have been distributed within the Bureau of Mines for refractory and other test work.

TABLE 11. - Andalusite-corundum concentrates

Flow sheet	Concentrate	Weight pounds	Particle size*	Specific gravity	Chemical analyses, percent						
					Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O	MnO_2**
1	1	440	Fine	3.37	62.6	34.5	0.89	0.71	0.27	0.11	0.75
1	2	640	do.	3.28	60.4	37.6	.98	.71	.29	.03	.13
1-2	3	1,587	Coarse	3.20	60.3	35.9	.63	.87	.36	.05	.10
2	4	588	Fine	3.31	67.6	29.3	.42	.77	.25	.02	.05
2	5	550	do.	3.36	69.2	28.7	.56	.87	.34	.02	.05
2	6	555	do.	3.36	67.1	28.7	.56	.77	.31	.07	.09
2	7	1,873	Coarse	3.33	66.3	29.5	.49	.77	.34	.07	.03
2	8	1,171	do.	3.40	72.4	25.2	.78	.82	.25	.06	.04
2	9	3,323	Fine	3.33	68.0	30.2	.42	.77	.17	.07	.10
3	10	752	Coarse	3.27	65.4	33.6	.54	.87	.35	.13	-
3	11	1,923	Fine	3.28	65.8	32.3	.58	.66	.29	.17	.10
Middling.	12	5,214	Coarse	3.08	52.1	44.9	.49	.77	.48	.25	.05
Do.	13	3,030	Fine	3.24	62.2	35.7	.42	.66	.26	.17	.12
Do.	14	221	Coarse	3.10	52.3	44.1	1.09	.77	.53	.19	.08
Clean-up.	15	556	Fine	3.22	59.0	39.6	.41	.77	.38	.07	.70
Hi-grade.	16	182	do.	3.76	91.5	5.7	.70	.77	.08	Tr.	.40
Composite		22,605		3.25	62.3	35.1	.53	.76	.32	0.15	-

*The fine size is approximately minus 65-mesh. The coarse size is approximately minus 20-mesh with some minus 100-mesh.
**MnO_2 is an extraneous impurity resulting from contact of the ore with launders, pipe lines, and other equipment that had previously been used for manganese milling tests.

Andalusite is marketed on a specification of 60 to 65 percent Al_2O_3 content and a specific gravity of 3.05 to 3.15. Many buyers also specify that 25 to 50 percent of the product should be minus 4- and plus 10-mesh. This latter specification was not met by any of the test products. Furthermore, it does not appear possible that such a specification can be met on the type of ore received, because of the intimate mineralogical association as shown by microscopic examination and in photomicrographs (figs. 1 and 2).

A weighted composite of all the concentrates produced analyzes 62.03 percent Al_2O_3, which would place this material in a class equivalent to a marketable grade of andalusite, provided that mineralogical character and refractoriness prove satisfactory. Material between 50 and 70 percent Al_2O_3 can be composited from the various lots for the refractory tests.

The distribution by weight, the chemical analyses, and specific gravities of the heads, tailings, and concentrates, are given in table 13.

Table 13. - Distribution and analyses of mill test products

Material	Weight, pounds	Chemical analyses, percent						Sp.g.	P.C.E.*
		Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O		
Concentrate	22,605	62.3	35.1	0.53	0.76	0.32	0.15	3.25	38
Coarse middling tailing.	6,718	37.3	61.4	.19	.87	.66	.17	2.92	31.5
Fine middling tailing	2,706	35.4	62.9	.14	.87	.52	.16	2.90	31^+
Tailing.	18,454	36.4	60.8	.19	.77	.61	.19	2.89	32.5^-
Slime.	44,600	35.6	61.4	.32	.92	1.14	.17	2.87	31^-
Calculated heading. .	95,083	42.2	55.1	.42	.85	.79	.17	2.97	-
Heading by analysis .	-	42.5	54.2	.33	.77	.73	.29	2.95	32

*Pyrometric cone equilvalent.

From the table, the ratio of concentration was 4.2 to 1. A lower-grade product containing between 50 and 55 percent Al_2O_3 may prove to be suitable for certain refractory purposes. A product made by combining the concentrates and the middlings as produced in this test operation would contain about 52.5 percent Al_2O_3; such a product would total 32,030 pounds, representing a ratio of concentration of 3.0 to 1.

CONCLUSIONS

1. Over 11 tons of table concentrates, in lots containing 50 to 70 percent Al_2O_3, were made from Hawthorne, Nev., ore. These are to be used for ceramic and refractory tests to determine their value in compounding high-alumina refractories.

2. If a certain standard quality of the concentrates analyzing between 50 and 65 percent Al_2O_3 proves to be of commercial value, such a product can be produced by table concentration. A commercial plant designed to provide well-classified and steady feed rates to tables undoubtedly could produce a fairly uniform product or a series of products varying in grade.

3. Specific-gravity determinations can be made quickly; they are reliable evidence of the product grade and may be used as a method of control in tabling operations.

4. The large proportion of minus 200-mesh fines produced by grinding suggests the possibility that additional recovery might be made by flotation on this material, provided such a product would have value. The formation of excessive amounts of fines in grinding is apparently an inherent characteristic of the ore, which is a mixture of hard and soft minerals, most of them extremely fine-grained.

5. Economic evaluation of a process for producing concentrates from Hawthorne ore by table concentration will depend upon the outcome of ceramic and refractory tests. Before such an appraisal can be made, the value and grade of a standard concentrate, as well as the use-value of any substandard byproduct, must be determined.

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A B S T R A C T

The Corunda Corporation controlls eighteen surveyed andalusite-corundum claims, located in the vicinity of Hawthorne, Nevada. Recent exploration work has shown ore reserves in excess of 1,000,000 tons. Bureau of Mines studies plus those made by Corunda Corporation has shown that concentrate products exhibit high refractory characteristics. These deposits are of the few known commercial deposits of its size in the United States and represent a western source of alumina refractory materials.

SCOPE AND IMPORTANCE OF ALUMINA REFRACTORIES

The following information and data are offered for purposes of aiding the evaluation of the Hawthorne Refractory Ore Deposits and as a means of refering to the many sources of written work concerning the refractory industry. It is to be pointed out that there are few, if any, completely written sources of information on the refractory industry, particularly in reference to sillimanite* types of refractories. Further information may best be obtained from governmental agencies and ceramic or refractory consultants who are familiar with alumina type refractories.

The refractories industry is not considered to be one of the largest industries but it is certainly one of the most important as any process that uses high temperature conditions must depend on refractories in one form or another.[1] Modern industry as we know it today, such as the manufacture of ferrous and non-ferrous metals, chemical and oil products, cement, power generation, etc., could not exist if refractory products were not available.

The early history of refractory usage dates back to the early ages of man and it is without doubt that the value of refractory rocks and minerals for the controlling of heat energy was quickly recognized. In spite of the early recognition of the value of refractories, their manufacture has been mainly an art until recently. Through chemistry, it was learned that oxides, silicates, carbides and nitrides of certain metals made up most of the refractory materials. Although many ingenious methods have been devised it was not until the advent of X-ray[2] studies that many minerals and substances could be identified due to their small size and indefinite composition.

Generally speaking, refractory products are made from various silicates, oxides, carbides and nitrides of metals which possess high melting or fusion points, are resistant to the chemical deterioration of combustion gases and other heat sources and must have load bearing capacity at high temperatures to withstand structural stress and strain. There are many different types of silicates and oxides that have been used in refractories manufacture. Aluminum silicates are the most commonly used raw materials and make up the chemical composition of most clays such as kaolin, bauxite, diaspore, sillimanite group minerals, etc. The oxide refractories are made up largely of magnesia, chrome, and dolime.

Modern industry steadily is increasing its demands for furnace refractories[3] that possess a combination of high mechanical strength, low porosity and shrinkage, and resistance to abrasion at high temperatures. In many instances these demands have been fulfilled best by high alumina refractories composed predominantly of the artificial mineral compound mullite, $3Al_2O_3 \cdot 2SiO_2$. Mullite is a product formed by the interaction of silica and alumina in correct proportions at relatively high firing temperatures or may be obtained as a transition product of the decomposition of minerals of the kyanite group (andalusite, kyanite, and sillimanite) at high temperatures.

High-alumina refractories are neutral[4] and they flux or form slags with difficulty; consequently, they are used widely in lead and glass furnaces, clinker-zone linings in Portland cement kilns,

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*The term sillimanite is used as a general name for the minerals andalusite, kyanite, dumorierite, topaz and sillimanite.

in boiler-furnace setting used for high-ash coals, and in blast furnace regenerators. A list of pr ometric cone equivalent values and chemical analyses of various grades of typical high alumina brick are given in table 1.[5]

HIGH ALUMINA CLASS	Alumina Range 50	60	70	80
	Analysis, %			
Al_2O_3	51.5	60.8	70.6	79.4
SiO_2	41.9	33.8	22.8	15.8
TiO_2	2.7	3.0	3.7	2.1
Fe_2O_3	1.8	1.7	1.8	1.7
Cao	.1	.2	.2	.2
MgO	.5	.3	.3	.3
Alkalies	1.2	1.1	1.0	1.0
P.C.E. Cone Number	34-35	36-37	38	39
Temperature equivalent, °C	1,773	1,815	1,835	1,865

The far western area of the United States has relatively few deposits of minerals containing enough alumina for use in the manufacture of high alumina refractories.[6] The common fact that western sources of high alumina minerals are limited, has had a disturbing influence on refractories manufacturers, who have been trying to keep pace with western industrial expansion needs. Furthermore, known deposits of sillimanite minerals of commercial importance are very limited in number for the entire United States.

It is not the purpose of this report to delve into the many ramifications of the refractory industry; however it is important to point out various trends and present day facts that enter into the evaluation of raw material resources. The present day supply of high-alumina minerals suitable for use in refractories is becoming less available.[7] It is generally known that good quality diaspore deposits in the midwestern regions are becoming depleted and substitute materials are being investigated. Bauxite has been used for some time but it has caused difficulty in refractories manufacture and the resultant products have been found inferior in many cases.[8] A combination of sillimanite minerals and corundum or diaspore[9] has been found to fulfill many of the properties of the diaspore type but the domestic supply of sillimanite minerals has heretofore been limited as previously mentioned. Due to uncertainty of supply and high prices, the expansion of sillimanite minerals usage has been limited. Some measure of the importance of these minerals is indicated by the fact that during World War II and the Korean War the government placed them in one of the highest strategic lists.

Mode of Occurance[10]

Andalusite--Andalusite is characteristically found in argillaceous slates and schists produced by contact-metamorphic action of granitic intrusives. Dioritic and more basic intrusives also may cause its formation. It is sometimes found within granite bodies, especially those of the two-mica variety. Mica schists and gneisses also may harbor it. It occurs as lenses and pockets in pegmatities and quartz masses and as replacement bodies produced by pneumatolytic action of residual magmatic solutions. It is not a typical product of regional metamorphism. It commonly occurs as long, prismatic crystals of nearly square cross section. Even in slates and schists, it sometimes grows to large size. The chiastolite variety featuring carbonaceous impurity arranged in a cross is typical of impure slates and schists. Large

crystal are usual in pegmatites and lenses in quartz and coarse, columnar crystal groups are not uncommon. A massive, granular, anhedral structure is also sometimes shown. Common associates are quartz, muscovite, pyrophyllite, diaspore, topaz, garnet, biotite, tourmaline, lazulite, rutile, dumortierite, and sometimes sillimanite and kyanite.

Composition and Structure[11]

The sillimanite group includes andalusite, kyanite, and sillimanite, all having the same chemical composition ($Al_2O_3SiO_2$) but different crystallographic, physical, and optical properties. Two other minerals, because closely allied in composition and thermal behavior, are also included in the group; that is, dumortierite and topaz, with the formulas $8Al_2O_3B_2O_36SiO_2H_2O$ and $Al_2(F,OH)_2SiO_4$, respectively. A sixth mineral, mullite ($3Al_2O_32SiO_2$) is formed by heating any of the other five to high temperatures: It must also be included, since its properties account for the merits of the group as ceramic raw materials. In the industry, the term "sillimanite" is often loosely used to indicate any of these minerals or their products. The aluminum silicate composition gives chemical stability important both in industrial use and in natural concentration of the minerals.

All these minerals crystallize in the orthorhombic system except kyanite, which is triclinic. Their internal structures are well understood and fairly complete X-ray data have been presented.[38, 149] Their X-ray patterns, obtained with an X-ray spectrometer, are reproduced in Fig. 1. Only sillimanite and mullite show similar patterns due to their very close structural similarity.[16, 89, 124] The existance of mullite was long overlooked because of this similarity, reflected also in similar optical properties. Laboratory study of the system $Al_2O_3SiO_2$ led to the discovery of the compound $3Al_2O_32SiO_2$, and to the proof that it rather than sillimanite is present in porcelain.[13] It was found in nature in the reexamination of some fused argillaceous sediments earlier described from the Isle of Mull, and was therefore named mullite.[14]

Physical and Optical Properties[12]

The ordinary physical properties usually suffice to distinquish the individual minerals, except when intimately intergrown with other minerals. Evaluation of such mixtures is often aided by determining the specific gravity,[56,118] the calcined appearance,[35] or the fluorescent response,[34] of typical lumps of the ore. The use of gravity separation during microscopic analysis of such ores has been described.[33] Hardness, coupled with chemical stability, leads to the preservation of placer deposits and residual boulders. Physical properties important in the beneficiation of impure ores are specific gravity, nonmagnetic and dielectric properties, and selective response to wetting agents.

Comparison of the optical properties of sillimanite and mullite makes it clear why the mullite in porcelain was long mistaken for sillimanite. Optical properties are useful in identifying the minerals in ore samples; they also permit rough quantitative analysis of the powdered ores, thusgiving rapid checks on the uniformity of successive shipments. Diffraction patterns obtained with an X-ray spectrometer can be used to a like end. In contrast, chemical analysis gives no direct information on the minerals present or their proportions but it gives such useful data as the $Al_2O_3SiO_2$ ration and the amounts of undesirable iron oxide, titania, and alkalies.

Thermal Properties[13]

Many studies have been made of the thermal behavior of the sillimanite minerals.[13,15,19,41,79,98,102,146,153] The principal results are summarized in Table 1. Behavior on heating is of paramount importance in the industrial use of the minerals. Except for mullite, which is stable up to 1810°C, all are unstable above 1545°C and break down at or below that temperature to yield mullite and free silica, the latter probably as cristobalite. Their role as mullite formers accounts for their value in ceramic products. Mullite imparts to the products such highly desirable properties as high refractoriness, low thermal expansion with resultant resistance to heat-shock, intermediate thermal conductivity, high load-bearing ability even at high temperatures, and resistance to chemical corrosion, particularly by acid slags.

The various minerals though similar in their decomposition products, differ in the temperatures required for both incipient and rapid decomposition, in microstructures, in volume and density changes, and in the relative proportions of mullite and silica. These factors have a bearing on the choice of mineral and the preparatory treatment, if any, it receives.

There is no fixed decomposition temperature for any of the group and the rate of breakdown for a given mineral varies with grain size, time and temperature.[5,15,41,122] The ranges given in Table 1 extend roughly from the temperature of earliest breakdown to that considered adequate in commercial practice. Topaz and dumortierite are the most readily dissociated, followed in order by kyanite, andalusite, and sillimanite. In practice, andalusite has an advantage in that mullitization is gradual and progressive at commercially attained temperatures. Sillimanite is scarcely affected at such temperatures, whereas the others are too readily decomposed.[16,122]

The volume changes on calcination affect the use of the minerals. All show a decrease in density, hence an increase in volume, on calcination. For all except kyanite, the change is so slight that they are essentially volume-constant and can be used without precalcining. Kyanite undergoes a notable expansion. It is, therefore, usually calcined before use, although in some cases raw kyanite in low percentages has been tried with success. Because of the expulsion of the bulk of their volatiles, dumortierite and topaz undergo weight losses of up to 6.6 pct[15] and 16 to 21 pct,[79,102,146] respectively. Despite this, they are practically volume-constant. For topaz, precalcination to eliminate fluorine is considered necessary, and is attended by difficulties.[20,102] Once completely mullitized, no further volume change occurs in any of the minerals, aside from the normal thermal expansion, except coarse-bladed kyanite. Recent work by Booze has given further information regarding the volume constancy of topaz on calcining at 3000°F. He states that continued heating at 3000°F would be necessary to render topaz suitable for refractory use.[165]

The calcined microstructure of the minerals varies somewhat. Kyanite, dumortierite, and topaz give an interlacing aggregate of mullite needles, said to promote mechanical strength. Andalusite and sillimanite show a parallel orientation of mullite crystals. Kyanite, on account of its expansion, gives a highly porous product. On the basis of the density decrease, this expansion should be about 16 pct but because of cracking and exfoliation it amounts to as much as 200 pct.[79] This is particularly true of the coarse, bladed domestic kyanite, which consequently has a high shrinkage and is difficult to bond in use. In contrast to the soft, friable grog of this type of kyanite, massive India

kyanite yields a hard, tough grog of considerably lower porotity.[79] The small amount of fluorine remaining in calcined topaz may have a beneficial mineralizing action in use.[102] The boric oxide released into dumortierite-bearing refractories on firing is believed to have similar merit.[118]

The modified $Al_2O_3SiO_2$ diagram is useful in evaluating the refractoriness of aluminum silicate minerals and mixtures. The superiority of andalusite, kyanite, or sillimanite over kaolinite or pyrophyllite is clear from a comparison of the relative amounts of siliceous liquid formed at or about 1545°C. Dumortierite and topaz have the advantage that their $Al_2O_3SiO_2$ ratio more closely approaches that of mullite, which gives no liquid up to 1810°C. The still greater refractoriness of such aluminous mixtures as electrocast mullite-corundum, calcined diaspore-clay or bauxite, and andalusite-diaspore mixtures is also apparent.

Certain other properties that are either strictly thermal or related to their use at high temperatures are highly significant in practical application. Electrical resistivity tests indicate that kyanite, sillimanite, and andalusite stand in that order as regards merit in this property.[66] Pertinent comparative data show the relative merits of mullite and other types of insulating materials as regards thermal expansion, resistivity, and thermal conductivity.[119]

Mineral Dressing

Mineral dressing techniques for treating and for concentrating sillimanite minerals vary depending on the mineral complexity and dissemination. Important physical properties that are used for concentrating have already been mentioned under physical and optical properties. Degree of expansion of the minerals in question must also be considered to determine whether calcination of products must be performed prior to use in ceramic or refractory manufacture. Purity of the ore obviously determines the degree and method of concentration. For instance, the White Mountain deposits controlled by Champion Sillimanite, Inc. are not concentrated excepting hand picking of ore as it is mined. Unfortunately, these deposits are quite limited as various economic factors such as accessibility and quantity of the deposits prevents their use as major source of refractory raw materials.

A typical mineral dressing system is described in the "Handbook of Mineral Dressing" by Taggart[14] for low grade kyanite ore. The feed averages 15% kyanite with varying amounts of garnet, quartz, mica and pyrite. Further written description of this method is given in "Industrial Rocks and Minerals".[15] The usual impurities and/or associated harmful minerals can easily be removed by making use of magnetic or wetting properties. Calcination methods are usually determined by the physical properties of the products. Due to the hardness of final products some care must be exercised in crushing and grinding with provision for removing abraded iron from ground products. Stone lined mills are usually used for fine grinding.

Production and Consumption

It is to be pointed out that there are few if any complete sources of information on production and consumption of sillimanite minerals. Statistics are not given to any great extent

which is peculiar to many besides the refractories industry, and furthermore no figures have been released since 1943.[16] Kyanite remains the preferred source material for mullite refractories due to availability. During World War II increased dependence on domestic sources led to an intensification of the search for higher grade deposits of sillimanite minerals. Domestic output was greatly stimulated because of the uncertainty of supplies from India. The trend in production and imports of kyanite in the United States is known to have increased very steadily since 1940, however actual volume is not known for reasons given above and the fact that output rarely reaches the open market until fabrication. The Kyanite Mining Corporation markets raw and calcined Virginia kyanite in grog sizes of 35 mesh and less. The Chas. Taylor Sons Co. distributes raw lump and ground calcined India kyanite. The Golwynne Chemical Co. and Mullite Refractories Co. market both India and Africa Kyanite ores. The P. B. Sillimanite Co. Ltd. distributes both India and Africa kyanite ores and products in Great Britain. The Champion Spark Plug Co. has marketed andalusite refractories as Champion Sillimanite, and its spark plug insulators bear the name, "Champion". The New Castle Refractories Co. markets kiln furniture containing andalusite. Sillimanite minerals are incorporated in products by the Richard C. Remmey Son Co., Laclede-Christy Clay Products Co., General Refractories Co., and Denver Fire Clay Co. The Coors Porcelain Co. and A. P. Green Fire Brick Co. are also included in this group.

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HAWTHORNE ANDALUSITE - CORUNDUM DEPOSITS
THE HAWTHORNE MINING DISTRICT
MINERAL COUNTY, NEVADA

The Hawthorne Andalusite and Corundum deposits are held by the Coranda Corporation and consist of the following unpatented lode claim groups: The Green Talc Group; the Victory Group; the Bismark Group; and the Deep Mines Group. All of these are located from within eight to twelve miles by road from the town of Hawthorne, Nevada. This area is located East of the southern end of Walker Lake and lies in general within the three townships of Range 31 and 32 East, Township 8 and 9 North, M.D.M., in Mineral County, Nevada. Three of the claim groups, the Green Talc, Victory and Bismark, lie on the southern slope of the Gillis Range of hills. The fourth group, consisting of the Deep Mine Claims, lies between Hawthorne and within a mile of the Southern Pacific Railway, which traverses the central part of Soda Springs Valley.

Location and Legal Description

ALTO AND GREEN TALC CLAIM GROUP:

Hawthorne Mining District, Mineral County, Nevada, approximately 5 miles in a northeasterly direction from Thorne, Nevada, in Township 9 North Range 31 East, in Sections 22, 23, 26, and 27. The claim group consists of Green Talc and Green Talc 1 through 4, the Green Talc Extension and the Alto Claim.

The Alto Claim is located as follows: Corner No. 1 is located 750 feet S47°00'W from the NE Corner of Section 27; thence 1500 feet N77°52'E to Corner No. 2; thence 600 feet S12°08'E to Corner No. 3; thence 1500 feet S77°52'W to Corner No. 4; thence 600 feet N12°08'W to Corner No. 1, the starting point.

The Green Talc Claim No. 1 is located as follows: Corner No. 1 coincides with Corner No. 1 of the Alto Claim; thence 895 feet S77°52'W to Corner No. 2; thence 607 feet N3°14'W to Corner No. 3; thence 897 feet N77°52'E to Corner No. 4; thence 607 feet S3°14'E to Corner No. 1, the starting point.

The Green Talc Claim No. 2 is located as follows: Corner No. 1 coincides with Corner No. 1 of the Alto Claim; thence 607 feet N3°14'W to Corner No. 2; thence 1500 feet N77°52'E to Corner No. 3; thence 607 feet S3°14'E to Corner No. 4; thence 1500 feet S77°52'W to Corner No. 1, the starting point.

The Green Talc Claim No. 3 is located as follows: Corner No. 1 is 262.6 feet N32°57'E from the SW Corner of Section 23; thence 1500 feet S77°52'W to Corner No. 2; thence 396 feet N3°14'W to Corner No. 3; thence 857 feet N63°50'E to Corner No. 4; thence 701 feet N77°52'E to Corner No. 5; thence 607 feet S3°14'E to Corner No. 1, the starting point.

The Green Talc Claim No. 4 is located as follows: Corner No. 1 coincides with Corner No. 1 of the Green Talc Claim No. 3; thence 607 feet N3°14'W to Corner No. 2; thence 1500 feet N77°52'E to Corner No. 3; thence 607 feet S3°14'E to Corner No. 4; thence 1500 feet S77°52'W to Corner No. 1, the starting point.

The Green Talc Extension is located as follows: Corner No. 1 coincides with Corner No. 1 of the Alto Claim; thence 600 feet S12°08'E to Corner No. 2; thence 1500 feet S77°52'W to Corner No. 3; thence 600 feet N12°08'W to Corner No. 4; thence 1500 feet N77°52'E to Corner No. 1, the starting point.

The Green Talc Claim is located as follows: Corner No. 1 coincides with Corner No. 2 of the Green Talc Claim No. 1; thence 831 feet S77°52'W to Corner No. 2; thence 607 feet N3°14'W to Corner No. 3; thence 832 feet N77°52'E to Corner No. 4; thence 607 feet S3°14'E to Corner No. 1, the starting point.

BISMARK GROUP:

Hawthorne Mining District, Mineral County, Nevada; approximately 8 miles due East of the Town of Thorne, Nevada, in Township 9 North Range 32 East, in Sections 31 and 32.

The Bismark Claim is located as follows: Corner No. 1 is located approximately 870 feet due South and 425 feet due East of the NE Corner of Section 32; thence 705 feet S57°15'W to Corner No. 2; thence 600 feet N7°00'E to Corner No. 3; thence 705 feet N57°15'E to Corner No. 4; thence 600 feet S7°00'W to Corner No. 1, the starting point.

The Bismark Claim No. 1 is located as follows: Corner No. 1 is located 870 feet due South and 425 feet due East of the NW Corner of Section 32; thence 600 feet N7°00'E to Corner No. 2; thence 452 feet N57°15'E to Corner No. 3; thence 987 feet S83°00'E to Corner No. 4; thence 600 feet S7°00'W to Corner No. 5; thence 987 feet N83°00'W to Corner No. 6; thence 452 feet S57°15'W to Corner No. 1, the starting point.

The Bismark Claim No. 4 is located as follows: Corner No. 1 is located 870 feet due South and 425 feet due East of the NW Corner of Section 32; thence 795 feet N57°15'E to Corner No. 2; thence 600 feet S7°00'W to Corner No. 3; thence 1500 feet S57°15'W to Corner No. 4; thence 600 feet N7°00'E to Corner No. 5; thence 705 feet N57°15'E to Corner No. 1, the starting point.

DEEP MINES GROUP:

Hawthorne Mining District, Mineral County, Nevada; approximately 7 miles southeasterly of Thorne, Nevada, and approximately 8 miles in a northeasterly direction of Hawthorne; located in Township 8 North Range 31 East, M.D.M., in Sections 13, 14, 23 and 24.

The Deep Mine Claim is located as follows: Corner No. 1 is located approximately 650 feet N35°00'W from the SE Corner of Section 14; thence to Corner No. 2, 1500 feet N51°00'W; thence 600 feet N39°00'E to Corner No. 3; thence 1500 feet S51°00'E to Corner No. 4; thence 600 feet S39°00'W to Corner No. 1, the starting point.

Deep Mine No. 1 Claim is located as follows: Corner No. 1 is located approximately 650 feet N35°00"W from the SE Corner of Section 14; thence 600 feet N39°00"E to Corner No. 2; thence 1500 feet S51°00"E to Corner No. 3; thence 600 feet S39°00"W to Corner No. 4; thence 1500 feet N51°00"W to Corner No. 1, the starting point.

VICTORY GROUP:

Victory Claim No. 1 is located as follows: Corner No. 1 is located 2,050 feet due South of the Northwest Corner of Section 25, Township 9 North Range 31 East in the Hawthorne Mining District, Mineral County, Nevada. From Corner No. 1, thence 600 feet N25°00"E to Corner No. 2; thence 748 feet S69°56"E to Corner No. 3; thence 752 feet S41°00"E to Corner No. 4; thence 600 feet S25°00"W to Corner No. 5; thence 752 feet N41°00"W to Corner No. 6; thence 748 feet N69°56"W to Corner No. 1, the starting point.

Victory Claim No. 2 is located as follows: Corner No. 1 coincides with Corner No. 1 of Victory Claim No. 1; thence 1500 feet N70°56"W to Corner No. 2; thence 600 feet N25°00"E to Corner No. 3; thence 1500 feet S70°56"E to Corner No. 4; thence 600 feet S25°00"W to Corner No. 1, the starting point.

Victory Claim No. 3 is located as follows: Corner No. 1 coincides with Corner No. 2 of Victory Claim No. 2; thence 392 feet S83°10"W to Corner No. 2; thence 1104 feet N89°47"W to Corner No. 3; thence 600 feet N25°00"E to Corner No. 4; thence 1104 feet S89°47"E to Corner No. 5; thence 392 feet N83°10"E to Corner No. 6; thence 600 feet S25°00"W to Corner No. 1, the starting point.

Victory Claim No. 6 is located as follows: Corner No. 1 coincides with Corner No. 3 of Victory No. 3; thence 450 feet N78°57"W to Corner No. 2; thence approximately 730 feet N67°00"W to Corner No. 3; thence 600 feet N25°00"E to Corner No. 4; thence approximately 730 feet S67°00"E to Corner No. 5; thence 450 feet S78°57"E to Corner No. 6; thence 600 feet S25°00"W to Corner No. 1, the starting point.

Victory Claim No. 4 is located as follows: Corner No. 1 is 400 feet N41°00"W of Corner No. 3 of Victory Claim No. 1; thence 1488 feet N81°00"E to Corner No. 2; thence 600 feet S41°00"E to Corner No. 3; thence 1488 feet S81°00"W to Corner No. 4; thence 200 feet N41°00"W to Corner No. 3 of Victory Claim No. 1, the starting point.

Victory Claim No. 5 is located as follows: Corner No. 1 coincides with Corner No. 2 of Victory Claim No. 4; thence 700 feet N74°27"E to Corner No. 2; thence 700 feet N77°15"E to Corner No. 3; thence 600 feet S41°00"E to Corner No. 4; thence 700 feet S77°15"W to Corner No. 5; thence 700 feet S74°27"W to Corner No. 6; thence 600 feet N41°00"W to Corner No. 1, the starting point.

LOCATION OF PROPERTY

The Coranda Corporation controls four claim groups, namely, the Green Talc, Victory, Bismark and Deep Mines. The first three groups are located in the extreme southeasterly portion of the Gillis Mountain Range. The Deep Mines Group is located in the extreme northeasterly outliers of the Excelsior Mountain Range. The first three named claim groups lie in a line which is approximately parallel to and at a distance of approximately four miles from the Southern Pacific Railway. All of the above claims are to be served by the Corporation's four surveyed mill sites, which are centrally located and adjoin the Southern Pacific Railway. (See Plan Map). The intervening terrain is gently rolling with a general downward slope towards the railway.

ECONOMIC FACTORS

The highway and rail net is excellent from the standpoint of commercial exploitation. Rail terminal facilities exist at Thorne, which lies northwest of the claim groups; however, the most practical terminal or siding point would be at the location of the mill sites. Road facilities to the mill sites would be considerably shorter and more economic from an operations standpoint.

The road serving the Green Talc group is for the most part controlled and maintained by the county, whereas the remaining portion is gravelled. The roads serving the Victory and Bismark groups are unimproved. The Deep Mines Group is served by a paved road excepting 200 yards.

POWER

Power for the territory is generated by the Mineral County Power System, with main offices in Hawthorne. A 33,000 volt high line passes within 0.2 mile of the south end of the Deep Mines group. A continuation of this line passes over the mill sites owned by the Coranda Corporation. The company's "E" commercial schedule contemplates a demand charge of $1.50/kw and energy charges as shown below.

WATER

Application for water rights has been applied for through the State of Nevada and has been approved. Water usage in excess of 800 gallons per minute is being allowed.

PREVIOUS HISTORY AND DEVELOPMENT

The original andalusite-corundum deposit, The Green Talc group, was discovered in 1922, whereas the Deep Mines, Victory and Bismark groups were discovered in latter years. Little development or mining work was performed on any of the claim groups up to 1945, excepting annual assessment work. It was learned that the ore from these deposits was not sufficiently uniform or of high enough alumina content[1,2] to be used directly in refractories manufacture. Mineralogical examination of this ore showed that it contained varying amounts of impurities and alumina content, making beneficiation necessary to remove any impurities and also to raise the alumina content. Preliminary mineral dressing tests performed by the Bureau of Mines, Salt Lake City, Utah, showed that the ore could be beneficiated by several methods.

During World War II searches and studies of domestic sillimanite deposits were greatly intensified, and one of the projects concerned the Hawthorne sillimanite deposits, which is reported in War Minerals Report 388. This work followed

that performed by the Salt Lake Station and took place at the Boulder City Bureau of Mines Station. These tests utilized tabling methods of concentration, which showed that this ore could be beneficiated; however, later work has shown much more efficient methods. A detailed discussion of this work will not be made at this time as reference, together with other material, will be given later in this report.

[1]War Minerals Report 888, Bureau of Mines, Dept of Int., pg. 1
[2]Reconnaissance Report on Andalusite properties near Hawthorne, Nevada, Schrotes, G. Austin, Mining Eng., July 5, 1941.

TOPOGRAPHY AND CLIMATIC CONDITIONS

The Hawthorne deposits are located in the lower foothills of two mountain ranges which form the sides of the valley in which the towns of Hawthorne and Thorne are located. A plan view map included in this report shows the relative locations. Maps showing the topography and geology of the deposits are also included.

Climatic conditions in the Hawthorne area are quite favorable, as atmospheric temperatures are moderate, and the yearly moisture precipitation is limited to approximately 3 inches. Several operations are located in the area which have found that no special provisions are necessary for all year operation.

RECENT EXPLORATION AND DEVELOPMENT

During the initial stages of the investigation of the Hawthorne andalusite-corundum deposits, several factors presented themselves which have had a direct bearing on the development of the deposits. These factors, some of which have already been mentioned, were, namely, that due to the character of the ore, it had to be beneficiated to effect uniformity and sufficient alumina content, that the ore could be beneficiated by various methods, and that mass mining and mechanical treatment of the ore were necessary for realizing an efficient and profitable operation. With consideration to the above factor a program of exploration and development was set up to determine whether ore of sufficient economic quantities was available or not. In brief, the program, which is discussed in detail below, consisted of geological mapping, exploration of the various ore bodies by diamond drilling, physical and chemical testing of drill cores, mineral dressing tests on ore from the various deposits and evaluation of the concentrates by refractory testing methods. Diamond drilling exploration and physical and chemical testing of the drill cores were carried out by means of a contract by and between Corunda Corporation and the Defense Minerals Exploration Administration, 10% and 90% of the costs being carried by Corunda Corporation and the D. M. E. A., respectively. Geological mapping of the deposits was performed by the U. S. Geological Survey and the Corunda Corporation. In addition to Bureau of Mines mineral dressing and tests on concentrates, the Corunda Corporation has had mineral dressing tests performed, thermal load tests and pyrometric cone equivalent tests made on concentrates .

GENERAL AND ECONOMIC GEOLOGY

Both the Gillis and Excelsior Mountain Ranges, in the vicinity of the claim groups, appear to be horsts or upthrown blocks, separated by a long trough-like graben or down-dropped block, now filled with talus from the boundary ranges.[1] The canyon mouths are invariably marked by long, partially dissected alluvial fans which probably cover the topographically lower favorable ore-bearing horizons.

By and large, both of the ranges in this vicinity appear to be made up in the aggregate of a varied assemblage of metamorphic rocks. It is in these schists, quartzites, etc. that the andalusite-corundum lenses occur. It appears that these bodies were formed by contact metamorphism, brought about by igneous intrusion into argillaceous country rocks and subsequently altered by hydrothermal action.[2] There is not much reason to believe that the character of the deposits would change at depth in view of information now available.

Quartzite, quartz and meta volcanic rocks have been found to be the most common diluents; however, the meta volcanic rock is most commonly found at the fringe areas of the ore pods and lenses. In general, the ore zones do not follow a definite direction; however, they trend in a northeasterly direction, as shown on the plan view map of the diamond drill holes.

Results of diamond drilling exploration in terms of ore reserves are discussed further on in this report.

[1]Reconnaissance Report on Andalusite properties near Hawthorne, Nevada, Schwotes, C. Austin, Mining Eng., July 6, 1941.

[2]War Minerals Report 388, Bureau of Mines, Dept. of Int, pg. 4.

MINERALOGY

Mineralogical analyses of the ore has been for the most part worked out at the Boulder City and Salt Lake City, Bureau of Mines Stations.[1] Recent additional information concerning the identification of halloysite by X-ray diffraction[2] has made an important bearing on mineral dressing techniques, the value of the ore, and an explanation of the thermal properties of the concentrates. Previously, it was thought that a dense-appearing green colored rock, which accompanies the ore, to be sericite; however, this rock has been proven to be halloysite. This accounts for the apparent discrepancy in War Minerals Report 388 concerning the quantity of mica present. Furthermore, this information pins down the reason why the sodium and potassium values were low, as the impure halloysite was mistaken for sericite.

Other x-ray diffraction work has shown that a common mineral in the ore to be diaspore and a minor mineral to be pyrophyllite. The diaspore was characterized as long grey prismatic crystals. The pyrophyllite appears as crystallized flower-like rosettes.

The character and occurrence of accessory minerals and diluents such as quartz and quartzite, hematite, magnetite and pyrite are of little consequence from a mineral dressing standpoint.

Photomicrographs of ore taken from the Green Tale and Bismark mines are shown on the opposite page. A comparison of these photographs with those illustrated in W. M. R. 388 illustrates the usual mineral dissemination that is found in the ore.

For all practical purposes the mineralogical association found in the Green Tale ore has been found to hold true in the varying grades of ore.

Mineralogical studies of various samples of Bismark ore have been made in preparation for mineral dressing tests. This work was performed at the Western Machinery Co. of San Francisco. Two types of samples were taken and were characterized as corundum and diaspore types, respectively. A photomicrograph of corundum bearing ore is shown on the opposite page. It was found that corundum and diaspore minerals were predominant with varying

amounts of andalusite and lesser amounts of pyrophyllite and halloysite. Micas were found in much smaller quantities than that found in the Green Talc ore. The common diluents were found to be quartz, quartzite and meta volcanics near fringe areas. Corundum mineral percentage was found to vary between 20-25% in corundum ore and diaspore mineral percentage varied to the same degree in diaspore ore. It was also found that the above types of ore occured in separate vugs and lenses varying in size from a few inches to several feet in thickness.

[1]War Minerals Report 388, Bureau of Mines, Dept. of Int. pg. 1.
[2]Letter, R. R. Lloyd, Chief Electrometalurgical Branch, Bureau of Mines, Boulder City, to Coranda Corp., May 1, 1953.

DIAMOND DRILLING EXPLORATION

The diamond drilling exploration work consisted of 2500 feet, 1600 feet of which was used on the Green Talc group and 900 feet on the Bismark group. This work, as previously stated, was carried out in conjunction with the D. M. E. A., under contract IDME-457, with a total amount of $36,000.00 being alloted. $28,750.00 of the above amount was alloted to carry out diamond drilling and engineering work, whereas the balance was alloted for chemical and physical tests of the drill cores. Diamond drilling was completed during the first half of this year, whereas chemical and physical tests are in the completion stages.

The diamond drilling was performed by the Diamond Bit and Tool Co. of San Francisco, who was contracted to do this work. Physical and chemical tests of drill cores are being performed by the Pittsburg Testing Laboratory of San Francisco. Considerable testing was also done by the Coranda Corp. laboratories.

For the most part NX size diamond drills were used for drilling with NX sizes being used for starting. AX size bits were used in several cases where found expedient.

Diamond drill logs of the cores are included in the latter part of this report. They were performed in conjunction with the Bureau of Mines and Mr. L. H. Scanger, Mining and Civil Engineer, who was retained by Coranda Corporation. It should be pointed out that these drill logs agree reasonably well with chemical analyses; however, some discrepancies may be noted, which is due to the difficulty involved in visual identification of the ore. Sillimanite minerals as they occur in the Hawthorne area have a varied coloring and character which is typical of these minerals.

CHEMICAL ANALYSES AND PHYSICAL TESTS

A large amount of chemical analyses and physical testing of surface samples, ore from mining pits and diamond drill cores have been performed. Initially, the Bureau of Mines performed analysis on 59 tons of Green Talc ore, which is reported in B. M. R. 388. The Bureau of Mines also analyzed one-ton samples of ore taken from the east pit (shown on topographical map) and from the West pit dump. These analysis are shown below.

SAMPLE	Al_2O_3	SiO_2	Fe_2O_3	K_2O	Na_2O	MgO	CaO	TiO_2	Fe_m	L.O.I.
	Percent									
59 ton sample	42.50	54.20	.42	.73	.28	--	--	.77	--	2.13
Ne-30.1	41.4	55.9	.43	.44	.23	--	--	.80	--	---
Ne-30.2	44.6	51.9	.33	.42	.20	--	--	.72	--	---

The following surface samples were analyzed by Coranda Corp. and are taken from points located on the Green Talc topographical maps.

GREEN TALC:

Sample No.	Al_2O_3	Percent SiO_2	Ign. Loss
GT-1	54.3	40.8	2.9
GT-2	50.5	40.9	5.3
GT-3	30.2	66.4	2.7
GT-4	26.20	44.9	7.9
GT-15	54.9	42.6	2.8
GT-16	51.5	42.8	3.40

BISMARK:

Sample No.	Al_2O_3	SiO_2	Fe	TiO_2	CaO	MgO	Mn_2O	K_2O
				Percent				
3-1	53.6	42.2	.57	1.90	Nil	Nil	.20	.60
3-2	55.2	38.6	.76	0.82	Nil	Nil	.30	.67

The following analyses concern diamond drill cores taken from ore bearing areas and ore used further on in this report for determining technically blocked ore reserves. For the sake of clarity and practical purposes the entire elemental analyses are not listed. Approximate averages of other constituents will be shown.

Each sample represents one-half of the split core length and vary in length from a few feet to 10 feet. The entire length of the drill cores is given after each hole listing.

HOLE #1.

Sample No.	Percent Al_2O_3	SiO_2
1-1	29.2	52.9
2-1	28.9	53.4
3-1	27.8	53.8
4-1	24.8	60.1
5-1	25.6	60.3
6-1	36.3	50.3
7-1	41.2	42.0
8-1	22.4	61.6
9-1	25.7	62.6
10-1	25.7	57.9
11-1	24.0	60.6
12-1	21.4	53.7

Sample No.	Percent Al_2O_3	SiO_2
15-1	28.3	59.6
16-1	36.9	47.7
17-1	20.3	64.7
18-1	30.5	57.2
19-1	37.8	45.6
20-1	25.3	60.9
AV	28.2	55.6

Length of Core 21' to 178'

Approximate Impurity Average:

Fe_2O_3	4.5%	Na_2O	.5
TiO_2	.7	K_2O	3.5
CaO	.8	L. O. I	4.0
MgO	.9		

HOLE #2.

Sample No.	Percent Al_2O_3	SiO_2
18-2	27.3	60.5
19-2	26.9	57.0
20-2	29.1	55.6
21-2	33.0	50.3
22-2	31.1	51.2
24-2	31.7	51.9
26-2	23.5	56.5
27-2	24.7	55.4
31-2	37.1	52.3
33-2	26.7	56.0

Sample No.	Percent Al_2O_3	SiO_2
34-2	23.9	56.5
35-2	24.0	62.6
36-2	28.9	57.0
37-2	38.1	44.1
38-2	26.5	53.7
39-2	26.2	57.2
40-2	24.9	62.7
41-2	32.4	52.5
42-2	27.1	57.3
43-2	27.0	56.4
44-2	28.0	53.6
Average	28.6	55.2

Length of core 117 feet to 183 feet and 205 to 282 feet.

Approximate Impurity Average:

	(Percent)		(Percent)
Fe_2O_3	3.8	Na_2O	.6
TiO_2	.8	K_2O	4.0
CaO	.4	L. O. I.	5.0
MgO	.3		

HOLE #3.

Sample No.	Percent Al_2O_3	Percent SiO_2
1-3	31.8	51.5
2-3	18.4	53.2
3-3	22.6	64.7
4-3	20.6	66.7
14-3	34.1	51.6
15-3	22.3	64.0
16-3	30.0	58.6
17-3	40.7	45.7

Sample No.	Percent Al_2O_3	Percent SiO_2
18-3	30.0	40.8
19-3	22.7	53.4
20-3	19.5	57.9
Av.	26.6	56.1

Length of Core 4-33 feet and 105 to 175 feet.

Approximate Impurity Average:

	Percent		Percent
Fe_2O_3	3.5	Na_2O	0.7
TiO_2	1.2	K_2O	4.0
CaO	0.4	L. O. I.	5.1
MgO	0.2		

HOLE #4.

Sample No.	Percent Al_2O_3	Percent SiO_2
2-4	24.0	58.3
3-4	28.2	62.9
4-4	27.0	65.2
5-4	24.9	66.6
16-4	19.4	73.5
17-4	25.8	67.5
18-4	33.0	59.4
19-4	38.1	53.9
20-4	34.6	59.4
21-4	24.9	63.5
Av.	28.0	62.2

Length of core, 10 - 48 feet and 105 through 170 feet.

Approximate impurity average:

	Percent		Percent
Fe_2O_3	3.0		
TiO_2	1.0	Na_2O	.3
CaO	0.2	K_2O	2.0
MgO	.3	L. O. I.	2.5

HOLE #5.

Sample No.	Percent Al_2O_3	Percent SiO_2
1-5	31.7	48.7
3-5	32.8	48.4
4-5	45.2	49.8
5-5	38.1	56.8
5-5-A	31.7	61.9
5-5-B	34.7	60.2
5-5-C	41.0	53.4
5-5-D	24.5	70.4
5-5-E	33.2	63.8

Sample No.	Percent Al_2O_3	Percent SiO_2
5-5-F	34.0	63.0
7-5	25.7	65.9
8-5	18.6	72.3
9-5	23.0	72.5
10-5	22.5	69.0
13-5	18.1	69.3
22-5		53.5
23-5		47.
24-5		51.
25-5		52.4
26-5		47.4
Av.	31.2	60.3

Length of Core, 5 - 117 feet, 155 - 210 feet and 225 through 250 feet.

Note: Complete analyses of the cores have not been made; however, the selection of samples that are analyzed are believed representative of the ore bodies indicated on the maps.

Approximate average impurities:

	Percent		Percent
Fe_2O_3	2.0	Na_2O	0.8
TiO_2	1.0	K_2O	2.0
CaO	.05	L.O.I.	4.0
MgO	.03		

HOLE #6.

Sample No.	Percent Al_2O_3	Percent SiO_2	Sample No.	Percent Al_2O_3	Percent SiO_2
2-6	33.4	53.1	12-6	34.8	59.7
3-6	20.9	57.0	13-6	31.0	59.6
4-6	40.0	45.4	14-6	34.4	61.0
4-6-A	31.5	57.1	15-6	34.0	62.7
5-6	33.8	56.8	16-6	32.7	62.8
9-6	33.4	57.0	17-6	34.8	61.9
10-6	31.4	57.0	20-6	37.7	56.6
			27-6	30.5	53.7
			Av.	32.9	57.3

Length of Core 4 through 229 feet.

Approximate impurity average.

	Percent		
Fe_2O_3	1.8	Na_2O	.3
TiO_2	.7	K_2O	1.5
CaO	0.1	L.O.I.	3.5
MgO	.1		

HOLE #7.

Sample No.	Percent Al_2O_3	SiO_2
5-7	30.2	61.40
9-7	32.3	53.60
15-7	30.5	53.8
28-7	21.2	56.5
Av.	28.6	56.3

Length of Core 50-130 feet and 145-213 feet.

Approximate average of impurities:

	Percent		Percent
Fe_2O_3	4.5	Na_2O	.6
TiO_2	1.5	K_2O	3.5
CaO	0.5	L.O.I.	4.0
MgO	1.0		

BISMARK MINE

HOLE #1.

Sample No.	Percent Al_2O_3	SiO_2
B-8-1	32.7	60.6
B-13-1	26.4	71.1
B-15-1	26.6	69.3
B-20-1	26.4	68.4
Average	27.8	67.3

Length of Core, 5 - 43 feet and 87 - 120 feet.

Approximate average of impurities:

	Percent		Percent
Fe_2O_3	0.6	Na_2O	0.1
TiO_2	1.0	K_2O	0.9
CaO	.04		
MgO	.02	L.O.I.	2.5

HOLE #2.

Sample No.	Percent Al_2O_3	SiO_2
B-4-2	28.5	62.5
B-5-2	21.0	69.5
B-15-2	24.0	72.6
B-16-2	25.5	69.5
B-17-2	21.4	72.7
B-18-2	22.9	74.0
B-19-2	28.2	65.2
B-20-2	25.9	66.4
B-21-2	22.1	69.1
B-22-2	18.5	72.4
Av.	23.9	69.4

Length of core, 32-42 feet and 110-through 174 feet.

Approximate impurities average:

	Percent		
Fe_2O_3	1.4	Na_2O	.3
TiO_2	1.2	K_2O	1.0
CaO	0.3	L.O.I.	2.5
MgO	0.7		

HOLE #3.

Sample No.	Percent Al_2O_3	SiO_2
B-8-3	22.1	65.5
B-11-3	22.9	56.6
B-17-3	32.9	50.0
B-20-3	30.1	56.6
Av.	27.0	57.2

Length of Core, 60 - 171 feet.

Approximate average of impurities:

	Percent		
Fe_2O_3	3.5	Na_2O	0.5
TiO_2	1.5	K_2O	3.0
CaO	2.0	L.O.I.	4.0
MgO	.7		

HOLE #4.

Sample No.	Al_2O_3	Percent SiO_2
B-3-4	31.7	57.5
B-8-4	26.2	59.7
Av.	28.9	58.1

Length of Core, 6 - 200 feet.

Approximate average impurities:

	Percent		Percent
Fe_2O_3	3.5	Na_2O	0.7
TiO_2	0.7	K_2O	3.2
CaO	2.5	L.O.I.	3.5
MgO	1.5		

HOLE#5.

Sample No.	Al_2O_3	Percent SiO_2
B-1-5	25.3	64.4
B-6-5	27.9	66.8
Av.	26.6	65.6

Length of Core, 100 - 171 feet.

Approximate average impurities:

	Percent		Percent
Fe_2O_3	0.5	Na_2O	0.15
TiO_2	0.5	K_2O	2.0
CaO	0.2	L.O.I.	3.0
MgO	0.1		

It should be pointed out that the various impurities listed in the above analysis are combined as magnetic minerals or as micas which may be readily removed by modern mineral dressing methods.

ORE RESERVES

The accompanying maps and cross sections of the various diamond drill holes show the areas of influence and the ore blocks. The following summary of ore reserves illustrates the positive and probable tonnage. The probable ore was calculated on the basis that ore would extend 50 feet deeper than the vertical depth of the drill holes. This is considered valid from geological nature of the lenses. In addition, ore lenses in the same vicinity which outcropped at lower elevations have been mined to a depth of 160 feet.

GREEN TALC MINE

POSITIVE ORE	CUBIC FEET
Block 1	77,000
Block 2	309,000
Block 3	553,500
Block 4	777,000
Block 5	1,654,000
Block 6	3,172,000
Total	6,542,500 cubic feet
Tonnage	575,000

PROBABLE ORE	TONNAGE
Above D.D.Hole #7	150,000
50 feet below D. D. Holes	400,000

Total positive and probable ore, 1,125,000 tons

The average weighted alumina content of this ore is 30.4%. This value was calculated on the basis of the areas of influence and the average chemical analysis of the drill holes.

BISMARK MINE

The positive tonnage was calculated by considering the width between the bottoms of No. 2 and No. 4 holes and the depth between surface ore over No. 3 and the bottom of No. 4 holes.

POSITIVE ORE

	Cubic Feet	Tonnage
	756,000	66,000
PROBABLE ORE *		
	2,352,000	206,000
Total	3,108,000	272,000 tons

* Probable ore was considered to extend to the depth of No. 4 hole.

The average alumina value was calculated to be 26.7%.

PROSPECTS OF FURTHER ORE DEVELOPMENT

The exploration work recently conducted covered only a small portion of the claim groups. In fact, approximately half of the claims were explored, whereas 16 other claims remain. The remaining areas hold very high promise for further ore development as outcrop areas are extensive and the mineralization is very similar to explored areas. A general idea of remaining mineralized areas are shown on claim survey maps. The outcrop areas are very general as no detailed geologic studies have been made.

MINERAL DRESSING TESTS

Although the mineral dressing tests conducted by the Bureau of Mines and reported in W. M. R. 388, are quite incomplete, important data were gathered. Since this work was conducted, other studies have been made by the Bureau

and the Corunda Corp. which have shown that considerably more efficient recovery of the alumina values can be made. Perhaps the most important discovery was made when the mineral halloysite was identified which was previously mistaken for sericite. As previously stated, this accounts for the low alkali values in the supposed mineral sericite, whereas the quantities of muscovite found in the ore would account fully for the alkalis present.

As may be easily recognized, the concentration method used and reported in W. M. R. 388, is not adequate for clean and efficient ore separation. This is inherently due to the nature of the ore and the sizing necessary to allow tabling.

Tabling requires rather close sizing of the ground ore, and to attain this end the ore has to be reground and classified several times. During this process the soft minerals, such as halloysite, slimes, and must be removed.

Although recovery of the other aluminum silicates besides andalusite and corundum were not attempted, further work by the Bureau of Mines showed more efficient means for recovering alumina values. This work is covered in an inter-Bureau letter.[1] Two one-ton samples of ore were treated by combination sink float, jigging and tabling methods. Several variations were used, all of which utilized coarse crushing followed by rejection of the gangue by sink-float methods. Various heavy media were used, such as ferrosilicon and galena. With the above methods concentrate varying from 50 to 55% alumina were produced with alumina recoveries ranging up to 60%. If adequate provisions for the recovery of other aluminum silicates had been made, the above method would have realized 80 - 90% efficiency.

Pilot plant sink-float methods of concentrating the ore have been tried and conducted at the Western Machinery Co. of San Francisco. It was found that concentrates of 50 - 60% alumina content could be readily attained with concentration ratios varying between 1.25/1 and 2.5/1, depending on the nature of the ore.

Further concentration of the sink-float concentrates may be performed by cyclonic heavy meadia methods and flotation.

Where magnetic and mica impurities occur in the ore they can be removed by magnetic and air flotation systems.

[1] Bureau of Mines Communication, Letter from H. G. Poole to Glen L. Allen, 3/14/45.

THERMAL PROPERTIES OF CONCENTRATES

In evaluating sillimanite minerals for commercial use, one of the most important characteristics is the refracteriness of ore or products. Several tests are used; however, the most indicative and important are pyrometric cone equivalents and thermal load bearing tests. The P.C.E. values reported for various concentrates in W. M. R. 388 are very high, being considerably above refractories commercially available. These values are listed below.

PYROMETRIC CONE EQUIVALENTS, ANDALUSITE-CORUNDUM CONCENTRATES

Concentrate	Assay, percent Al_2O_3	SiO_2	P. C. E. No.
1	62.6	34.5	37+
2	60.4	37.6	37+
3	60.3	35.9	38-
4	67.6	29.3	38
5	69.2	28.7	39
6	67.1	28.7	40
7	66.3	29.5	38+
8	72.4	25.2	38
9	68.0	30.2	40+
10.	65.4	33.6	38
11.	65.8	32.3	39+
12.	52.1	44.9	36+
13.	62.2	35.7	38+
14.	52.3	44.1	35-
15.	59.0	39.5	37.5
16.	91.5	5.7	41-
Composite . . .	52.3	35.1	38

Further work has been performed on 50% alumina class concentrates, which were made from Bismark ore via Wemco sink-float methods. The following table gives the chemical analysis of the two products tested:

Sample No.	L-343-1	L-343-2
Al_2O_3	54.25	56.51
SiO_2	42.12	46.00

These concentrates were of coarse sizing, minus 1/2 inch plus 10 mesh and represent the lower range in alumina content as they were separated at a 2.94 gravity. L-343-1 was characterized as containing corundum and andalusite with associated halloysite and pyrophyllite minerals. L-343-2 was characterized as containing diaspore, pyrophyllite and halloysite.

Samples of each ore were thermally load tested by one of the major refractory company research laboratories according to standard methods.[1] In that Sample L-343-1 was made up of corundum and andalusite, it was considered unnecessary to precalcine the concentrate as material of this sort is volume stable at high temperatures. Diaspore is of higher specific gravity and expands on firing in its conversion to mullite.

The following table illustrates the results of the thermal load tests:

Sample No.*	L-343-1*	L-343-2	Arco 70
Point of Incipient[1] Fusion	1410° C	1405° C	1340° C
% Deformation	0.31%	0.30%	0.35%
Point of 1% Deformation	1457° C	1460° C	1410° C
Point of 4% Deformation	1482° C	1500° C	1485 ° C
10% Deformation	1492° C	1520° C	

* L-343-1 - Uncalcined corundum and andalusite
L-343-2 - Calcined Diaspore
Arco 70 - General Refractories - 70% alumina brick

[1] 25 psi load applied.

The specimens were loaded thermally under compression and in a slightly reducing atmosphere which may give lower failure points.

A comparison of the values found for Areo 70 show that samples L-343-1 and L-343-2 are of exceptional refractoriness.

The following table gives the shrinkage values of the specimens fired at 1500° C.

Sample No.	L-343-1	L-343-2	Areo70	Periclase
% Shrinkage	0.74	0.66	1.8	3.0
Density gm/C.C.	2.38	2.05	-	-
Density #/Cu.ft.	148	128		

The shrinkage values for samples L-343-1 and L-343-2 are very low in comparison with commercial refractories. The high density of the specimens show a relatively low porosity.

The following table shows the P. C. E.[2] values for the above samples.

Sample No.	L-343-1*	L-343-2*	70% Alumina Brick
P.C.E. equivalent	37-38	38	36-37
Temperature °C	1820-1835	1835	1810-1820

*These samples were tested at Pittsburg Testing Laboratories, San Francisco, Calif.

The above results show and substantiate the data obtained in the above load tests.

Although it is known that alumina ores of the above nature readily convert to the desirable constituent mullite, it is exceptional that bonding strengths and refractoriness of this nature results. It is believed that the presence of corundum in L-343-1, which is unattacked up to 1910° C, plus the bonding influence of assessory minerals account for the high strength.

H. Brodkey
Supervising Ceramic Engr.

[1]Journal of American Society, Nov. 1941, pg. 345, "An Automatic Apparatus for Testing Refractories Under Tensile and Compressive Loads at High Temperatures", J. A. Scarlet and Dr. J. A. Robertson.

[2]Manual of A.S.T.M. Standards on Refractory Materials, A.S.T.M. C-24-46, pg. 74.

OPERATIONAL COSTS OF MINING AND CONCENTRATING

The total operational costs for mining, hauling, concentrating, royalties, etc. has been estimated at $7 - $10/ton of concentrates, on a 200 ton of concentrates/day basis. The cost of the first three items has been estimated by the Western Machinery Co. and given in a letter, a copy of which is included in this report. These costs were based on 80% recovery of the alumina values and a product that would contain 50% alumina. This estimate is believed very adequate as considerable contingencies have been included.

Cost of calcining, crushing, grinding and screening of condentrates has been estimated at $25/ton.

VALUE OF ORE DEPOSITS

In computing the value of the ore deposits, selling prices of the finished products have been tentatively set at $45/ton for raw concentrates and $70-$100/ton for calcined concentrates. These prices would be F.O.B. Hawthorne, Nevada, and are within the price structure of similar commercial products. On the basis of 2.5 tons of raw ore per ton of concentrates, the gross value of the ore reserves previously listed is estimated to be worth $25,000,000. The net value is estimated to be in excess of $19,000,000.

MARKETS - USES

An accurate survey of the markets for sillimanite products is not available at the present time. As previously stated, no statistics have been released for some time; however, it is known that alumina refractories make up the bulk of the annual refractory dollar volume. During World War II the total refractory value reached $180,000,000 per year.[1]

1 "Refractories", Norton, F. H., third ed., p. 3.

HELMUT BRUCHMANN

Today's industry has steadily increasing demands for highly developed and manufactured ceramics of many different types with different properties. Those ceramics are:

Refractory type with uniform rate of thermal expansion and resistant to spalling and deformation under load. They are strong and tough and stable at high temperatures.

Alumina porcelain has high refractoriness, great resistance to chemical action at all temperatures, high mechanical strength, great hardness and resistance to abrasion, high electrical resistance even at high temperatures, impermeability to gases and translucency and excellent resistance to thermal shock (Part. use in aircraft insulators).

Steatite type ceramics with modulus of rupture well above 17,000 lbs. p.s.i., because of its development of mullite and cordierite it shows mechanical roughness, accuracy of dimension, high density, high dielectric breakdown values and particularly low dielectric loss and low power factors. It is the latter two properties that make them particularly valuable for radio insulators because of the high frequency currents that are employed in such applications.

Other ceramics of the electrical type with specific properties are:

Condense porcelain
Laboratory procelain
Ceramic coating of metal
Vacuum tight porcelain

The wide variety of these porcelains are important for modern industry. They are mainly used in the electrical field for high and low voltage, in aircrafts, for radar equipment, receiving and transmitting technique, in jet exhausts, for spark plugs and many other equipments.

For the manufacture of some ceramics of that type, Andalusite is an important raw material. It is preferred for mullite type whiteware and refractory bodies, since its volume stability, refractoriness and ready conversion to mullite are desired characteristics.

I have all formulas and know all processing techniques and manufacturing methods, since I developed and manufactured above mentioned ceramics from 1939 until 1946 when I was employed with Siemens-Schuckert and Halske in Germany. I was in charge of research, development, production and control in a Siemens-Schuckert-Halske plant, employing 1200 workers. This Company is known as the leading concern in its field in Europe.

I graduated from a school of technology for silicate industry in Köthen, Germany as Ceramic Engineer. 20 years experience in various leading ceramic plants in Germany. In Sept. 1949 I came to Canada under special order of council as Ceramic Engineer to develop a ceramic industry in Western Canada. I am in the United States as immigrant on a permanent visa.

References: Mr. E. M. Hommel, President of the O. Hommel Co., 209-213 Fourth Avenue, Pittsburgh, Pennsylvania, and Mr. A. D. Browne, Vice-President and General Manager of the Pacific Electric Manufacturing Corporation, 5815 Third Street, San Francisco 24, California.

C O P Y

WESTERN MACHINERY COMPANY

"WEMCO PRODUCTS"

EXbrook 2-4167
760-766 Folsom Street
San Francisco 7, California

September 11, 1953

Coranda Corporation
386 Race Street
San Jose, California

Attn: Mr. J. H. Rodda, President

Gentlemen:

It is our opinion, based upon similar operations, but with a different character of ore that on a basis of 500 TPD, that is, 500 tons in 10 hours, the mining, trucking, crushing and treating by Heavy Media Separation including operating costs of the Heavy Media Plant should not exceed $2.00 per ton of feed or $5.00 per ton of concentrate, based on an assumed 40% weight recovery. We believe that this is a conservative figure and is safe to use for estimating purposes. However, there is one item that at present is not exactly clear and that is the cost and the location of a well to supply the Heavy Media Plant with a sufficient amount of water to treat this tonnage (50 TPH) not having any information as to the possible source of water we could not include this in the cost estimate previously indicated.

The Heavy Media Plant will require 5 GPM a ton per hour of feed on the washing section which is that part of the plant where the ore must be thoroughly washed and the minus 10 mesh material removed before the feed passes into the HMS Plant. It will also require about 4 GPM as wash water in the Heavy Media Plant which makes a total of 9 GPM per ton hour of feed or about 450 gallons of water per minute. Part of this water can be reclaimed by overflowing it into a thickener and the solids settled out and the overflowing water from the thickener returned to a steady head tank ahead of the HMS Plant. You can calculate that about 60% of this water and at times up to 80%, depending upon the settling rate of the solids, can be recovered.

We appreciate very much discussing these problems with you and assure you of our cooperation at all times. We are,

Very truly yours,

WEMCO DIVISION
Western Machinery Company

/s/ Irvin S. Thyle

/t/ Irvin S. Thyle
Sales Engineer
Western District

IST:js

Docket No. DMEA-2512
Contract No. Idm-E457

Green Talc Mine
Mineral County, Nevada

Diamond Drill Log, Hole #1
Strike S 57° 8' E, Dip 20°00'

Feet From	To	Core Size	Description
0	21	NX	Over burden - no core recovery.
21	27	"	60% C. R. 21' to 25' meta volcanics, dark ground mass.
25	27	"	Ore zone-sericite inclusions.
27	34	"	General ore zone - dark inclusions.
34	39	"	Same as above - ground mass becoming darker.
39	45	"	Lean meta volcanics 50% C.R. Some ore inclusions, becoming more mineralized at 42'
42	45	"	Ore zone.
45	47	"	Solid ore.
47	50	"	General ore zone, solid.
50	55	BX	Broken up ore zone. Sericite inclusions.
55	60	"	50% C.R. Ore zone.
60	65	"	Solid ore-darker ground mass - good ore.
65	70	"	60% C.R. Good ore zone - black barren seam of meta andesite 69-70'.
70	71	"	70% C. R. 70-71' ore showing.
71	75	"	Dark ground mass-barren meta volcanics. Possible corundum showing at 74'. 74-75' lean mineralization.
75	76	"	75 - 76' meta volcanics.
76	82	"	Broken up ore zone. Less mineralization from 80-82.
82	85	"	Ore zone - dark ground mass. More highly mineralized.
85	90	"	80% C. R. Ore zone - more barren from 85 to 90'. Low grade ore at 90'.
90	95	"	General ore Zone. Poorly mineralized 94-95'.
95	100	"	Highly broken up zone - meta volcanics. No ore showing.
100	105	"	Meta volcanics, dark ground mass 90% C.R. Material solid.
105	110	"	Same as above - lighter ground mass - considerable shear action or plate like structure. 100% C.R. 70% C.R. Meta volcanics.
115	120	"	115'-117' lighter ground mass-porphrytic structure. 117'-120' Feldspar crystals altered to Kaolin. 70% C.R.
120	125	"	Darker ground mass, meta volcanics 50%. More broken up.
125	130	"	Same as above.
130	135	"	80% C.R. Same as above.
135	140	"	70% C.R. Same as above. Altering at 140' to sericite.
140	145	"	Sericite with Al-Si, black inclusions shown, 20% C.R.
145	150	"	Same as above.
150	155	"	Highly broken sericite zone changing to mud seam.
155	160	AX	No core recovery - changed to AX drill size at 160'.
160	165	"	Ore zone - dark inclusions - highly broken up. 30% C.R.
165	170	"	60% C.R. Light ground mass, sericite, Al-Si showing.
170	175	"	60% C.R. Same as above showing kaolinization.
175	180	"	Sericite-same as above altering to showing of meta volcanics 178-180.
180	185	"	20% C.R. Highly broken up country. Meta volcanics, Occasional Al-Si showing.
185	190	"	20% C.R. Light colored meta volcanics.
190	195	"	Mud seam - 5% C.R.
195	200	"	No core recovery-mud seam.
200	208	"	100% C.R. Dark colored meta volcanics-highly siliceous - scattered sulfides showing. Bottom of hole.

Docket No. DMEA-2512
Contract No. Idm-E457

Green Talc Mine
Mineral County, Nev.

Diamond Drill Log- Hole #2
Strike N.°45 W; dip 25° N.W.

Feet From	Feet To	Core Size	Description
0.0	15.0	NX	No core.
15.0	20.0	"	Occasional quartzite boulders in overburden.
20.0	26.0	BX	Highly brecciated silicified meta-andesite, iron-stained fractures, occasional manganese stain in fractures.
26.0	31.0	"	Dark granular silicified meta-andesite, gradually becoming more silicious, quartz breccia inclusions.
31.0	31.5	"	Small sericite particles in oxidized, brecciated silicified fault stringer.
31.5	37.0	"	Silicified meta-volcanics containing quartz breccia inclusions. Iron-stained fracture at 33 feet. Core becoming unconsolidated, occasional core.
37.0	47.0	"	Schistose structure, sericitized, becoming more massive, occasional sillimanite minerals observed. Hematite streaks and vugs in sericite and quartzite matrix. Hematite making up about 5% of rock mass at 45 to 47'.
47.0	65.0	"	Extremely vuggy quartzite, considered true quartzite, iron stains impregnating material. Occasional area showing pyrite mineralization. No sericite observed. Blue green material in quartz matrix at 53.2 (copper mineralization). Fresh pyrite becoming more pronounced at 60 to 65 feet.
65.0	66.0	"	White bull quartz, epidote filling of fracture.
66.0	67.0	"	Quartzite containing fresh pyrite, oxidized and vuggy in part.
67.0	75.0	"	Browinish fine sand, becoming claylike, epidote in matrix. No core recovered 70-75 feet.
75.0	79.0	"	Soft, partially granular, and base material, assuming sandstone appearance. Gradually becoming harder and having appearance of silicified meta-volcanic.
79.0	80.0	"	Broken silicious material, occasional epidote in fractures.
80.0	90.0	"	Micaceous appearing material, very soft becoming harder; could be altered (volcanic like material). Very slightly sericitized at 81 feet.
90.0	107.0	BX	Sericite in quartzite, epidote noted at 91 feet. Core recovery 28% to here. No core from 100 to 105 feet. Sericite in schistose structure at 105 feet, becoming softer, changing to sericite pebbles in soft (kaolinite) matrix.
107.0	117.0	"	Hard silicious material, pyrite mineralization, no ore.
117.0	130.0	"	Broken sericitic silicified at edge of ore zone, sillimanite minerals quite prominent, poor core recovery. Fault structure, oxidation, between 128-130 feet.
130.0	135.0	"	Sericite cementing dark gray to black mineralized inclusions (meta-andesite.)
135.0	144.0	"	Kaolinized zone, occasional sericite, containing prominent sillimanite minerals. Dark gray inclusion from 137-139 feet and again at 141-142.5 feet. Remainder very light in color.

Docket No. DMEA-2512
Contract No. Idm-E457

Green Talc Mine
Mineral County, Nev.

Diamond Drill Log - Hole #2
Strike N. 45° W; dip 25° N.W.

Feet From	To	Core Size	Description
144.0	146.0	"	Dark inclusions, believed to be (meta-volcanics) cemented with sericite, becoming more mineralized at 146 feet.
146.0	151.0	"	Predominately sillimanite minerals, fractured and recemented with sericite, highly sheared area 148-150 feet. Good core recovery.
151.0	156.0	"	Light porus, dark grained (altered and decomposed diorite dike), granular appearance, associated with a black (schist) material, contact material noted at 156 feet. No mineralization.
156.0	172.0	"	Predominately (kaolinite) associated with sillimanite minerals, black schist inclusions, becoming progressively darker in color with occasional sericite and andalusite observed, dark (schist) material has crinkly appearance. Believed to be mineralized.
172.0	173.0	"	Schist structure altering to a brecciated mud, some sericite in breccia (possible fault structure).
173.0	180.0	"	White kaolinite material cementing dark schist, crinkly effect. Some mineralization.
180.0	180.5	"	Soft granular purpole zone (meta-andesite?). No mineralization.
180.5	187.0	"	Dark schist, sericitization in fracture. Light brown crystals (pyrite casts) altered to hematite, scattered through rock mass.
187.0	190.0	"	Green sericite altered to clay, occasional Al-Si gouge zone.
190.0	195.0	"	Highly broken zone, sericitized, some clay, bull quartz and pyrophyllite noted at 195 feet.
195.0	201.0	"	Less broken, solid core, sericite, becoming cherty towards 200 feet.
201.0	212.0	"	Bands of sericite, somewhat silicified in schistose structure. Solid sericite at 206 feet and at 212 feet.
212.0	215.0	"	Gradual transition from massive sericite to sericite and meta-andesite schist; schist partly replaced by sericite and monor amounts of Al-Si.
215.0	225.0	"	Silification of meta-andesite.
225.0	230.0	"	Sericite - meta volcanics.
230.0	230.5	"	Darker ground mass broken up. Some sericite.
230.5	233.0	"	Contact, change in structure to finer ground siliceous structure. Sericite. Lighter ground mass increasing mineralization - 233.
233.0	235.0	"	Meta-volcanics, silicified.
235.0	237.0	"	Same as above. Contact changed to definite mineralization (sillimanite minerals (Al-Si).
237.0	240.0	"	Same as above, altering to meta volcanics, sericite.
240.0	245.0	"	Broken up meta volcanics with sericite.
245.0	247.0	"	Meta volcanics with some mineralization and darker ground mass.
247.0	248.0	"	Mineralization changing to meta volcanics.
248.0	250.0	"	Meta volcanics silicified.

Docket No. DMEA-2512
Contract No. Idm-E457

Green Talc Mine
Mineral County, Nev.

Diamond Drill Log - Hole #2
Strike N. 45° W; dip 25° N.W.

Feet From	To	Core Size	Description
250.0	251.0	"	Mineralized zone Al-Si.
251.0	255.0	"	Meta volcanics - some sericite changing from dark to lighter ground mass.
255.0	257.0	"	Alteration to mineralized zone Al-Si.
257.0	[illegible]	"	Alteration to meta volcanics. Silicified changing to darker ground mass.
260.0	263.0	"	Meta volcanics. Light ground mass with dark inclusions.
263.0	264.0	"	Mineralization Al-Si.
264.0	265.0	"	Meta volcanics.
265.0	270.0	"	Meta volcanics becoming increasingly mineralized Al-Si.
270.0	275.0	"	Meta volcanics with sericite inclusion. Slight mineralization.
275.0	280.0	"	Same as above becoming more broken up.
280.0	282.0	"	Same as above.
282.0	285.0	"	Mineralization, ground mass becoming more broken up.
285.0	286.0	"	Alteration to dark ground mass, meta volcanic. Bottom of hole.

Diamond Drill Log - Hole #3
Strike N. 45° W; dip 20° N.W.

Feet From	To	Core Size	Description
0	4.5	NX	White (kaolinite)? changing to greenish cast sericite containing sillimanite minerals.
4.5	16.0	BX-5'	Soft mica schist inclusion, occasional gneissoid schist. No mineralization.
16.0	19.0	"	Greenish sericite containing sillimanite mineralization.
19.0	33.0	"	White kaolinite with occasional sericite inclusions, becoming progressively more mineralized at 26 to 33 feet.
33.0	41.0	"	Fine grained quartzite (no contact material) noted. Epidote at 41 feet. No mineralization.
41.0	45.0	"	Soft mud gouge assuming schistose structure, silicified and harder at 45 feet. No mineralization.
45.0	56.0	"	Considered to be quartzite at 45 feet, occasional epidote in fractures, in dark grained silicified meta-andesite, some mottled effect quartz breccia inclusions.
56.0	56.5	"	Black fine-grained dike (unknown width) lamprophyre cutting.
56.5	66.0	"	Mottled silicified meta-andesite, dark, containing occasional epidote fillings in fractures.
66.0	90.0	"	Dark mud gouge, soft sandstone appearance, meta-andesite and altered schist. Little to no core.
90.0	97.0	"	Harder schistose material at 90 feet, very little core, softer material at 95 to 97 feet becoming mud and clay at 97 feet. No mineralization. 26% core recovery to here.
97.0	99.0	"	Fractured flaky sericite, containing quartzite, brecciated and recemented.
99.0	105.0	"	Fractured quartzite, oxidized in fractures, pyrites in fresh rock. No sillimanite minerals.
105.0	115.0	AX	Dark brown quartzite, slightly brecciated, minor amounts of sericite in fractures. Pyrites in fresh rock, oxidized in fractures.

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Green Talc Mine
Mineral County, Nev.

Diamond Drill Log - Hole #3
Strike N. 40° W; dip 20° N.W.

Feet From	Feet To	Core Size	Description
115.0	138.0	AX	Sericite, minor amounts of sillimanite minerals, poor core recovery. Rock becoming kaolinized at 130 feet, sericitization of fractures, increasing sillimanite minerals, (corundum).
138.0	148.0	"	Black inclusions (meta-volcanics) cemented with sericite.
148.0	150.5	"	Light green sericitic material sillimanite materials present.
150.5	158.0	"	Dark silicious meta-volcanic) rock, slightly sericitized in fractures.
158.0	162.0	"	Dark mottled silicious schist, small lamprophyre dike at 159.0 feet. Very small amount of sericite noted. Schist becoming lighter in color to 162.0 feet.
162.0	170.0	AX	Light gray porphyritic schist, no mineralization, good core recovery. Slight sericite seam observed at 166.0 feet.
170.0	185.0	"	Hematite noted at 176.0' and again at 180.0 to 185.0 feet in porphyritic schist. Slightly
185.0	195.0	"	silicified at 178.0 feet.//Predominantly light gray porphyritic schist, slightly silicified. No mineralization.
195.0	198.0	"	Black schist, kaolinite inclusions (probably altered sericite).
198.0	200.0	"	Black firm grained sand. Very little core. Bottom of hole.

Diamond Drill Log - Hole #4
Strike N 45° W, Dip - 20°00'

0	3	NX	Overburden
3	5	"	Meta volcanics - dark ground mass. Fine crystal structure, black in color. Dense, dark grained basalt G. C. R.
5	10	"	Same as above G. C. R.
10	15	"	Same except more broken up at 14' - 15' G.C.R.
15	17	"	Lighter ground mass - alteration phase at 17' G.C.R.
17	20	"	Lighter ground mass becoming mineralized at 20' G. C. R.
20	25	"	Becoming highly mineralized at 24' - inclusions of sericite in light ground mass, kaolinite.
25	30	BX	Same as above.
30	35	"	Mineralized zone becoming darker in color.
35	40	"	Low grade ore - some pyrite and hematite inclusions - becoming more mineralized. 100% C.R.
40	45	"	Ore zone G.C.R.
45	48	"	Lower grade ore zone.
48	50	"	Becoming siliceous - darker ground mass - hematite inclusions.
50	52	"	Same as above but with purplish cast - suspected mineralization. (sillimanite 50% C.R. broken up.)
52	55	"	Broken up country - oxidized inclusions of talc, 50% C.R.
55	60	"	Low grade mineralization, kaolinite structure 50% C.R. conglomeration of ore particles shot through, light ground mass - meta volcanics.

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Green Talc Mine
Mineral County, Nev.

Diamond Drill Log - Hole #4
Strike N 49° W, Dip - 20°00'

Feet From	To	Core Size	Description
60	65	EX	Broken up country - Iron inclusions at 60' - Hematite, oxidized surface - some mineralization. Contact or change at 64' lighter ground mass - brecciated. 50% C.R.
65	68	"	66' Meta volcanics - showing mineralization - 68'
68	70	"	Same as above.
70	72	"	Light ground mass, meta volcanics, hematite seams - mineralization. Some kaolinization.
72	75	"	60% C.R. Light colored ground mass - silicified - mineralization, ore zone. Manganese - 74'. Sandstone structure light ground mass.
75	80	"	Quartzite. Broken up. 40% C.R.
80	85	"	10% C.R. Mud seams - intervening Iron stains - quartzite - purplish cast - through 85' oxidized surfaces.
85	90	"	Same as above.
90	95	"	Same as above. 60% C.R.
95	100	EX	Quartzite showing sulfide - 60% C.R. Oxidized seams.
100	105	"	5% C.R. Broken up quartzite, showing considerable iron oxidation.
105	110	"	No. C.R.
110	115	"	10% C.R. Kaolin or talc-like material.
115	120	"	Meta volcanics, sericite inclusions showing at 117' becoming increasingly mineralized with sericite. 70% C.R.
120	125	"	Sandy structure altering to meta volcanics, altering to sericite at 123'. 60% C.R. becoming mineralized at 122' - general ore zone.
125	130	"	Ore zone. Al-Si - sericite inclusions.
130	135	"	Same as above.
135	140	"	C.R. 50% Ore zone - corundum seams showing. Good ore.
140	145	"	90% C.R. Good ore zone.
145	150	"	Same as above except darker ground zone.
150	155	"	Al-Si altering to meta volcanics - dark ground mass.
155	160	"	Highly siliceous material changing from dark to light ground mass.
160	165	"	Altered to Al-Si ore zone at 160'. 160-165 ore zone.
165	170	"	Ore zone 100% C.R. altering to meta andesite. Ore zone 100% C.R. Some mineralization.
170	175	"	Same as above.
175	180	"	Meta andesite - highly brecciated light ground mass with dark phenocrysts. 100% C.R.
180	185	"	Same as above - sericite showing 185'. Meta andesite - dark ground mass.
185	190	"	Same as above. 80% C.R.
190	195	"	Same as above at 195' altering to kaolinized structure. 60% C.R.
195	200	"	Same as above - some mineralization at 197' becoming more broken up. Sericite showing at 198' Bottom of hole.

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Mineral County, Nevada

Diamond Drill Log - Hole #5
Strike S 45°00' E, Dip-30°00'

Feet From	To	Core Size	Description
0	5	MX	Overburden
5'	6'6"	"	Al-Si Minerals-sericite. G.C.R. Becoming broken up.
6'6"	7'	"	Mud gouge - P.C.R.
7'	14'	"	Alteration to ore zone with green sericite inclusion. G. C.R.
14'	20'	"	Ore solid - good quality. General ore zone. G. C.R.
20'	25'	"	Green sericite more predominant. G.C.R. General ore zone.
25'	30'	"	Quality of ore decreasing - ore zone solid. Buff colored material dispersed throughout G.C.R.
30'	40'	"	Same as above. G. C. R.
40'	49'	"	General ore zone becoming quite broken up. Fair C.R.
49'	51'	"37'	Mud gouge - no mineralization. P.C.R. Mud seam
51	55	"	Same as above
55	57'5"	"	White talc-becoming mineralized.
57'5"	64	"	Mineralized ore zone, light buff ground mass G. C.R.
64	69	"	General ore zone broken up at 69'.
69	73	"	Not so fractured at 70'. Becoming broken up at 72'. Light buff ground mass - ore zone.
73	78	"	General ore zone - more sericite inclusions.
78	83	"	78-80' broken up ore zone - mud seam to 83'. Clay and talc G.C.R.
83	88	"	Ore zone - broken up
88	95	"	Ore zone - less broken up. Light buff ground mass - becoming more quartzitic.
95	100	"	Ore zone - sericite inclusions.
100	106	"	P.C.R. Ore zone- Corundum showing quite strongly
106	110	"	P.C.R. Brecciated ore zone.
110	117	"	50% C.R. General ore zone - Solid
117	122	"	Broken up material ore zone.
122	124	"	Ore zone-solid.
124	127	"	Quartzite-showing scattered pyrite on fresh surface and some oxidation. Alteration at 127' to kaolinization.
127	129	"	General ore zone - not highly mineralized,80% C.R.
129	132	"	Highly kaolinized-showing Al-Si inclusions. Solid ore.
132	134	"	General ore zone - tending towards kaolinization. Solid ore, 90% C.R.
134	139	"	Ore zone. Well mineralized. Solid ore zone. 60% C.R.
139	144	"	Highly broken up ore zone. Sericite inclusions 50% C.R.
144	149	"	20% C.R. Same as above.
149	154	"	40% C.R. Same as above becoming well kaolinized and altering to quartzite at 154'.
154	155	"	Quartzite, oxidized seams, altering to light green sericite, highly broken up.
155	159	"	Sericite inclusions in dark ground mass. Meta andesite-somewhat broken up altering to Al-Si mineralization.

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Green Talc Mine
Mineral County, Nevada

Diamond Drill Log - Hole #5
Strike S 45°00' E, Dip-30°00'

Feet From	Feet To	Core Size	Description
159	160	NX-37'	159'-160' solid ore zone-some sericite inclusions, becoming highly broken up. 90% C.R.
160	162	"	Highly broken up ore zone. 90% C.R.
162	164	"	75% C.R. Same as above.
164	168	"	75% C.R. Highly broken up ore zone-meta volcanic inter-mixed.
168	174	"	Solid ore zone - considerable sericite included. 70% C.R. Small amounts of meta volcanics in vugs.
174	179	"	100% C.R. Highly broken up ore zone-showing shear planes. Some dark masses included.
179	184	"	40% C.R. Same as above.
184	189	"	Crushed zone - some ore showing, sandy structure.
189	194	"	Altered meta volcanics, 80% C.R. Dark olive or mud appearance on wetting. Considerable brecciation. Alteration to low grade ore.
194	197	"	Highly broken up low grade ore zone. 50% C.R. Some meta volcanics showing in pebbles.
197	200	"	10% C.R. Highly broken up ore zone-sericite inclusion and meta volcanics.
200	210	"	Same as above except highly sheared and tending to a schistose structure. 10% C.R.
210	215	"	Highly broken up meta volcanics - dark ground mass.
215	225	"	Same as above except lighter ground mass.
225	230	"	Meta volcanics - highly broken up, very siliceous.
230	235	"	Meta volcanics - highly brecciated - pyrites and oxidized faces.
235	240	"	Same as above.
240	250	"	Same as above.

Diamond Drill Log Hole #6
Strike S 72°15' E, Dip-30°

0	5	"	Overburden
5	8	"	Quartzite boulder at 5'; broken up condition at 5.5', meta andesites, somewhat brecciated with sericite and Al-Si mineralization. Country highly broken up at 7'. Highly mineralized with sericite and dark inclusions. 100% C.R.
8	10	"	Same as above except kaolinized structure. Becoming more mineralized with Al-Si and corundum. General ore zone 100%.
10	20	"	Ore zone, showing corundum and Alsi, some dark inclusions and sericite. Small seam of meta volcanics at 16-17', 100% C.R., broken up zone at 19', 19.5-20-meta volcanics.
20	25	"	Meta volcanics, dark ground mass, solid structure, broken up seam at 25', small inclusions of sericite.
25	29	"	Meta volcanics, dark ground mass, solid structure to 27'. Broken up zone from 27 - 29' altering to sericite and Alsi with inclusions of quartzite - 60% C.R.

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Diamond Drill Log Hole #6
Strike S 72°15' E, Dip-50°

Feet From	Feet To	Core Size	Description
29	33	NX-37'	Sericite structure and Al-Si minerals. Mineralization increasing. Small seam of broken up country at 30', 100% C.R. Alteration to meta andesites at 31'. Alteration to Al-Si ore mineralization at 33'
33	37	"	General ore zone with some andesites at 33-35', broken up at 37'-38'. 90% C.R.
37	43	"	90% C.R. General ore zone, broken up 39-41'.
43	48	"	43-44.5 ore zone, highly kaolinized, 44.5' - 48', meta andesite, light ground mass, small specks of manganese, becoming highly broken up and soft at 48', kaolinized.
48	54	"	Kaolinized structure light ground mass, highly broken up, becoming more oxidized P.C.R. 20%.
54	59	"	Highly broken up to 58', seams of hematite and sericite in andesite. Light ground mass 58'-59', 20% C.R.
59	65	"	Meta andesite to 60', alteration to sericite and AlSi. General ore zone.
65	71	"	General ore to 70' altering to more silicious material at 71'. 100% C.R.
71	76	"	Change at 71' to general ore zone. Increasing corundum showing. 100% C.R.
76	81	"	Ore zone becoming more coarsely crystalized. Siliceous in appearance.
81	86	"	Highly broken up andesites, light ground mass to 86', highly oxidized faces. Ground mass changes markedly to dark color, meta volcanics. 20% C.R.
86	90	"	Meta volcanics, dark ground mass. 80% C.R.
90	91	"	Same as above.
91	96	"	Highly broken up ore zone. no apparent change in structure to indicate alteration zone. 92-96' ore zone solid, sericite inclusions. 100% C.R.
96	99	"	96-97' ore, altering to meta volcanics, alternating dark ground mass for few inches, then light ground mass to 99'. 100% C.R.
99	105	"	Meta volcanics-dark ground mass with light patches. 100% C.R.
105	110	"	105-107' same as above altering to sericite mineralization. Highly broken up to 110'. 70% C.R.
110	114	"	Ore zone to 114' where rock is becoming quartzitic. 90% C.R.
114	120	"	Broken up at 114', altering to general ore zone, quite siliceous to 120'. 100% C.R.
120	125	"	General ore zone same as above excepting rock more solid. 100% C.R.
125	130	"	General ore zone. 100% C.R.
130	136	"	Same as above. 100% C.R.
136	138	"	Same as above. 100% C.R.
138	146	"	Same as above, alteration at 146 to meta volcanics with AlSi shot through, dark ground mass.
146	150	"	Alteration from meta volcanics at 147' to general ore zone, darker in color. 100% C.R.
150	154	"	Ore zone to 153' where alteration takes place to quartzite with ore shot through to 154'. 100% C.R.

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Green Talc Mine
Mineral County, Nevada

Diamond Drill Log Hole #6
Strike S 72°15' E, Dip - 30°

Feet From	Feet To	Core Size	Description
154	161	NX-37'	Quartzite with streaks of Al-Si mineralization to 158'. Ore zone to 161, 80% C.R.
161	164	"	General ore zone, seam of hematite with ore shot through at 163'. 100% C.R.
164	170	"	Alteration to meta volcanics at 164', dark ground mass to 170' where sericite inclusions occur, highly broken up at 171'. 80% C.R.
170	176	"	Meta volcanics with small inclusions of sericite, P.C.R. 10%.
176	179	"	Same as above, P. C. R. 10%.
179	186	"	Alteration to Al-Si and sericite at 186', P.C.R. 20% highly broken up.
186	191	"	Alteration to meta andesites at 186', becoming increasingly darker with phenocrysts becoming frequent, 100% C.R.
191	197	"	Meta volcanics, dark ground mass, highly broken up from 195 - 197'.
197	201	"	Same as above, faces oxidized, highly broken up, C. C. R. 100%, some sericite inclusions.
201	205	"	Highly silicious meta volcanics highly broken up, 20% C.R.
205	208	"	Same as above, becoming sandy. P.C.R. 20%.
208	212	"	Meta andesites, lighter ground mass, rock more solid.
212	216	"	Same as above, 60% C.R.
216	221	"	Same as above, 60% C.R.
221	226	"	Same as above, 80% C.R.
227.5	231	"	Alteration at 227.5 to Al-Si continuing to 229 where another alteration occurs, meta andesites with sericite inclusions to 231, 80% C.R.
231	236	"	Changing to darker ground mass at 231, faces show oxidation, continuing to 236'.
236	243	"	Same as above. End of hole.
(Insert above) 226	227.5	"	Same as above, 90% C.R.

Diamond Drill Log - Hole No. 7
Strike S 72°15' E, Dip - 30°

Feet From	Feet To	Core Size	Description
0	4	"	Meta volcanics, light ground mass to 4'.
4	5	"	Black siliceous dike altering back to meta volcanics at 5'. 100% C.R. Highly broken up.
5	20	"	Alternating dark and light ground mass made up of meta volcanics. Mud seam at 15'. 15'20' meta volcanics. 30% C.R. Highly broken up.
20	30	"	Lighter colored meta volcanic to 25'. 25' to 30' very light ground mass, meta volcanic. 50% C.R. Broken up country. Highly altered.
30	40	"	Meta volcanic, altered; appears somewhat kaolenized. Light ground mass. Highly broken up.
40	45	"	Same as above. 60% C.R. Highly broken up. Highly altered.
45	47	"	Very highly broken up. Same as above. P.C.R.
47	48	"	Rock more solid. Light colored meta volcanic. Small seams of hematite, altering to sericite at 48'. 90% C.R.

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Green Talc Mine
Mineral County, Nevada

Diamond Drill Log Hole #7
Strike S 72°15' E, dip-30°

Feet From	Feet To	Core Size	Description
48	50	NX-37'	Same as above. 90% C.R.
50	55	"	Sericite to 53' where material changes to meta volcanics and continues to 54' where alteration to sericite occurs; back to dark meta volcanics at 55'. 100% C.R.
55	60	"	Dark meta volcanics to 56' changing to light ground mass. 90% C.R.
60	65	"	Lighter colored meta volcanics to 62'. Broken up country for few inches, altering to dark material blue to blackish color. Suspected corundum, 62-64'. 80% C.R. 64-65', dark blue to black. Hematite seams. Suspected corundum. Somewhat siliceous in appearance. 100% C.R.
65	70	"	65-67' same as above, altering to darker meta volcanics. Dark cyrstals still appearing. 60% C.R.
70	75	"	Alteration to meta volcanics, changing from dark to light ground mass at 74'.
75	80	"	Same as above excepting blue cast which appears to contain corundum. Mineralization. 90% C.R.
80	85	"	Dark meta volcanics changing to lighter ground mass at 83'. 80% C.R., changing to dark meta volcanics at 84' with considerable mineralization. Highly altered.
85	90	"	Change-sharply at 86' to light colored oxidized meta volcanics, highly altered phenocrysts. 70% C.R.
90	95	"	60% C.R. Light colored meta volcanics, somewhat broken up.
95	100	"	100% C.R. Sericite showing at 95' in light meta volcanics which continues to 97'. Oxidized surfaces. Changes to lighter meta volcanics, considerable mineralization. Core solid. Hematite seams at 100'.
100	105	"	100% C.R. Hematite spots and seams in meta volcanics. Light ground mass. Considerable mineralization.
105	110	"	Meta volcanics with bluish cast. Altering to sericite and Al-Si minerals at 107'. General ore zone to 110'. 100% C.R.
110	115'	"	100% C.R. Continuing general ore zone to 113' where alteration takes place to light colored meta volcanics which continues to 115'.
115	120'	"	Continuing meta volcanics more broken up. Oxidized surfaces. Ground mass changing to dark color at 118'. Continuing meta volcanics to 120'. 80% C. R.
120	125'	"	Continuing meta volcanics lighter in color, somewhat broken. Highly broken up at 125'. 80% C.R.
125	130	"	Continuing light colored meta volcanics to 126' where alteration to sericite and Al-Si minerals take place. Continues solid to 128' where county is highly broken up. General ore zone. 80% C.R. Alteration at 130' to porous quartzite., greyish cast.
130	135	"	Continuing porous quartzite to 134' where alteration takes place to light colored meta volcanics. Considerable hematite.

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Green Tale Mine
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Diamond Drill Log - Hole No. 7
Strike S 72°15' E, Dip-30°

Feet From	To	Core Size	Description
135	140	NX-37	Continuing meta volcanics. Changing to porous, highly altered material, appearance of kaolin somewhat soliceous. 10 % C.R.
140	145	"	Light colored meta volcanics becoming highly broken. 100% C.R.
145	155	"	70% C.R. Same as above. Considerable oxidation. Alteration to Al-Si at 149-150'. Alteration back to meta volcanics at 150'. Light ground mass. 100% C.R. Rock mass solid 150-155'.
155	160	"	Continuing meta volcanics. Same as above to 156' where alteration takes place to Al-Si minerals, which continues to 158' where material becomes marginal, 160'. 100% C.R.
160	165	"	Al-Si material quits at 160' and material is light colored meta volcanics. Continues to 161' when ore mineralization occurs again, which continues to 165' where ore zone is of good quality. 80% C.R.
165	170	"	Ore zone continues to 166' where alteration takes place to meta volcanics. G. C. R.
170	175	"	Continuing meta volcanics. 80% C.R.
175	180	"	Changing to darker meta volcanics, continuing to 180'. 100% C.R.
180	185	"	Same as above. 100% C.R.
185	190	"	Some Al-Si mineralization at 186'. Hematite seams showing in meta volcanics at 186-187'. Meta volcanics continuing bluish cast at 187.5'. 100% C.R.
190	195	"	Continuing meta volcanics. Lean ore showing at 192-193', changing back to meta volcanics which continues to 195'. 100% C.R. Dark cast.
195	200	"	Continuing dark colored meta volcanics. Some Al-Si mineralization. 100% C.R.
200	205	"	Same as above to 204' where Al-Si mineralization changes to definite ore zone. 100% C.R.
205	213	"	Same as above. 100% C.R. Bottom of hole.

Bismark No. 1 Mine
Mineral County, Nev.

Docket No. DMEA-2512
Contract No. Idm-E457

Diamond Drill Log - Hole No. 1
Strike 70° W. Dip 30°

Feet From	To	Core Size	Description
0	8	"	Meta volcanics and overburden. 6-7' Lime and clay structure, light ground mass. 7-8' meta volcanics with schistose structures. 25% C.R.
8	14	"	8-10': Same as 7-8'. 10-12': meta volcanics, alteration to schist-like structure, dark ground mass. 12-14': meta volcanics with schistose structure. Darker at 14'. Grey-blue in color. 100% C.R.

Docket No. DMEA-2812
Contract No. Idm-E457

Bismark No. 1 Mine
Mineral County, Nevada

Diamond Drill Log - Hole No. 1
Strike 70° W. Dip-30°

Feet From	Feet To	Core Size	Description
14	19	"	Dark blue colored metal volcanics. 14-16': where color changes to grey color, brecciated with schistose structure. Core breaks along planes of the schist. 17-18': andesite structure with some mineralization. Tendency towards brecciation. 18-19': continuing schistose structure lighter in color from 18-19'. 100% C.R. Ore showing 18-19'.
19	23	"	19-20': ore structure. 20-23': very pronounced schistose structure. Tendency towards brecciation. Predominant meta volcanics.
23	25	"	Same as above. at 24.5' some iron stain. 80% C.R.
25	29	"	100% C.R. 25-26': broken up schistose structure to 26'. Alteration to mineralization, continuing 26-29'. Ore structure at 28-29'. 100% C.R. Diaspore showing at 29'.
29	34	"	29-31': alteration to quartz. Showing indication of diaspore. 31-32': alteration to meta volcanics with considerable hematite stain. Alteration at 32' to ore zone to 34'. 100% C.R.
34	43	"	Ore zone. Good quality, very small seams or vugs of white quartz. 60% C.R. Core showed difficulty in drilling.
43	48	"	Quartz-like structure with mineralization. Ore showing through core. 80% C.R. Better quality ore showing at 48'.
48	52	"	Ore showing to 52'. Some quartzite. Glass-like. 80% C.R.
52	57	"	Ore showing. Considerable quartz in ore. Solid structure. Minor change at 57'. Oxidized surfaces. 100% C.R.
57	67	"	Some quartz seams through ore. Good quality ore showing at 63'. Alteration at 64' to quartz. Quartz showing to 67'. Some light colored material similar to feldspar. 70% C.R.
67	68	"	Light colored schist, showing some mineralization. Considerable quartz showing. 67-68' ore quality increasing rapidly. Ore zone. 100% C.R.
68	74	"	General ore zone. Diaspore showing with some pyrophylite crystals showing. 80% C.R.
74	80	"	74-75.5, ore zone altering to schist. Broken up at 77-80', considerable brecciation. 80% C.R.
80	83	"	Alteration to light colored meta volcanics with schistose structure. 90% C.R.
83	88	"	Darker colored meta volcanics at 83' showing alteration of phenocrysts. 40% C.R.
88	91	"	Same as above except lighter in color. No mineralization. 10[illegible]% C.R.
91	95	"	Same as above to excepting quartzite seam at 92'. 80% C.R.
95	104	"	Dark colored meta volcanics, broken up. 50% C.R. 97-104' dark colored meta volcanics with considerable quartz shot through. Broken up to 98'. Lighter colored meta volcanics. Grey-banded structure. At 100-102. 102-103', clay-like. Plate structure. Light colored changing to highly mineralized Al-Si. Ore zone at 104', 70% C.R.

Docket No. DMEA-2512
Contract No. I4m-E457

Bismark No. 1 Mine
Mineral County, Nevada

Diamond Drill Log - Hole No. 1
Strike 70° W. Dip-30°

Feet From	Feet To	Core Size	Description
104	109	NX-37	General ore zone. Somewhat broken up. 90% C.R.
109	115.5	"	Same as above. 80% C.R.
115.5	120	"	Ore zone - 117. Less mineralization to 120'. Solid structure to 120'. Some small seams of quartz at 117'. 90% C.R.
120	125	"	Alteration to meta volcanics at 120' continuing to 128' where alterations take place to pronounced schistose structure. Highly broken up. 100% C.R.
125	130	"	Highly broken up material to 127'. Schist and clay structure. 127' - alteration, to meta volcanics. Mineralized at 128'. Increasing mineralization to 130'. 100% C. R.
130	135	"	Soft clay material at 130'. Light buff coloring. Small seams of montronite at 133-134'. 90% C. R.
135	140	"	Change to AX Core. Quartz and shale. 10% C. R.
140	145	"	Shrly meta andesite. Schistose structure. 50% C. R.
145	150	"	Same as above. 50% C. R. Bottom of hole.

Bismark No. 2
Mineral County, Nevada

Diamond Drill Log - Hole No. 2
Strike S 75° E, Dip -30°

0	15	"	Overburden. Sand
15	22	"	Meta andesite highly broken up and light grey ground mass with white colored phenocrysts. 60% C. R.
22	27	"	Same as above.
27	32	"	Schistose structure to 28'. Alteration to sericite to 32'. 40% C. R.
32	37	"	Green sericite to 35', broken up. Alteration to light grey meta andesite. Some iron stain at 37'. 100% C. R.
37	42	"	Light grey andesites with pronounced schistosity. 100% C.R.
42	45	"	Same as above with quartz intrusions.
45	48	"	Light colored meta andesites with schistose planes nearly parallel with drill hole. 100% C. R.
48	56	"	Same schistosity to 51'. Broken country at 51-56'. Schist. 50% C. R.
56	60	"	Solid formation at 56'. Considerable mineralization at 58-60'. Badly broken up from 57-60'. White fine grained material closely resembling texture of Al-Si ore. 100% C. R.
60	71	"	Continuing high mineralization to 66'. More solid formation. 60% C. R. 66-71' continuing mineralization. 40% C. R. Broken up. Light ground mass.
71	76	"	Light sandy material appearing to be diaspore. No C.R.
76	80	"	Solid formation. Quartzite with mineralized seams-very light colored. 100% C.R.
80	85	"	Same as above, with sericite in seams. 100% C.R. Appearance of feldspar.
85	91	"	Continuing quartzite. Sericite percentage increasing and at 90' ore zone, 91'. 80% C.R. Broken up at 90-91'.

Docket No. DMEA-2512
Contract No. Idm-E457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole No. 2
Strike S 70° E, Dip-30°

Feet From	To	Core Size	Description
91	96	NX-37	91-93', ore zone. Less mineralization. 90% C. R. More solid formation.
96	101	"	Quartzite material, light colored ground mass. Little mineralization. 60% C.R.
101	106	"	White colored ground mass. Opaque, very finely crystalline, some sericite. 90% C.R. Appears to be quartzite. Alteration at 106 to mineralization.
106	112	"	General ore zone. Diaspore. Some buff colored material. 90% C.R.
112	116	"	Ore zone. Very solid core. 100% C.R.
116	121	"	Ore zone. 100% C. R.
121	125	"	Continuing ore zone, 126'. 100% C. R.
125	130	"	Less mineralized in light ground mass to 127'. Ore zone-130'. 80% C. R.
130	134	"	Broken up country to 134'. Highly mineralized ore showing in places. 40% C. R.
134	140	"	Mineralized zone up to 140'. Buff colored ground mass. 70% C. R.
140	144	"	Ore zone. Light buff in color. 90% C. R.
144	146	"	Same as above. 100% C. R.
146	151	"	Same as above. Diaspore crystals evident. 100% C. R.
151	156	"	Ore zone. 100% C. R.
156	161	"	Very broken up ore zone. Poor core recovery. 20% C. R.
161	166	"	Poorer quality ore zone. Some intrusion of andesite. Banded structure. 50% C. R. At 163' alteration to andesites with occasional mineralization to 166'
166	169	"	Schistose structure, some mineralization in meta andesites.
169	174	"	Same as above. More mineralized. 30% C. R.
174	181	"	Meta andesites with zone of quartzite at 176-181'. 40% C. R.
181	196	"	Continuing quartzite with some pyrophyllite showing. Some ore showing at 191-196'. Highly broken up. 20% C. R. Some Diaspore showing.
196	200	"	Schistose structure at 196. Altering to black metal volcanics. Very poor C. R. 5%. Bottom of hole.

Diamond Drill Log - Hole #3
Strike N 70°W, Dip 30°

2	2.5	NX	Few inches of schistosed meta volcanics.
2.5	7	"	Quartzite. Solid formation. 60% C. R.
7	10	"	Quartzite. Solid formation. 60% C. R.
10	15	"	Same as above. 80% C. R.
15	20	"	Slight alteration of quartzite at 15'. Reddish brown hematite stain which continues to 20'. C. R. 40%. C. R. 100%
20	23	BX	Quartzite with reddish stain to 23'. 100% C.R. Solid formation.
23	27	"	50% C. R. Mineralization starts at 23'. Light green, small areas shot through core. Mineralization increasing to 27'.
27	32	"	Mineralization continuing. Material more broken up. Light ground mass, appears to be mixture of quartzite and Al-Si minerals 40% C.R.

Docket No. DMSA-2512
Contract No. Idm-E457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole #3
Strike N 70° W, Dip 30°

Feet From	Feet To	Core Size	Description
30	35	BX	Mineralization or low grade ore continuing to 34' where quality increases to a general ore zone which continues to 35'. 80% C.R.
35	41	"	Solid core, general ore zone. 75% C. R.
41	46	"	Ore zone becoming quite lean at 41' where quartzite is becoming predominatn, country more broken up. 50% C. R.
46	50	"	60% C. R. Ore and quartzite-country broken up.
50	55	"	Material at 53' still broken, green Al-Si minerals more predominant. Mineralization decreasing to 53' where quartzite is predominant. 75% C. R.
55	60	"	10% C. R. Highly broken up ore zone. Schistosed material.
60	65	"	10% C. R. Same as above.
63	65	"	50% C. R. Alteration at 63'. Reddish honey combed material with some mineralization. Material becoming highly schistosed at 64'. Green Al-Si minerals.
65	70	"	90% C. R. Continuing schistose structure. Occasional green Al-Si minerals showing. Alteration at 67' to schistosed meta volcanics with oxidized surfaces, continuing to 70'.
70	75	"	Wavy surfaces on shear planes. Plate like partings. 100% C. R.
75	81	"	70% C. R. Same as above. Platy structure more predominant.
81	86	"	Dark ground mass still prevailing (meta volcanics, country broken up. 50% C. R.
86	91	"	80% C. R. Same as above. Some mineralization.
91	95	"	Material altere to a light colored schistosed structure-slight mineralization. Platy surfaces. Continues to 94' where mineralization increases to 95'. 90% C. R.
95	100	"	C. R. 20%. Broken up country, some mineralization showing in the schist.
100	105	"	Continuing schist to 102' where alteration occurs to darker meta andesites which continues to 105'. 100% C. R. Country not quite so broken.
105	111	"	100% C. R. Dark meta andesites. Some oxidized surfaces continuing to 111.
111	116	"	At 111' country very broken, schistosed light material to 114' where alteration to dark meta andesites takes place which continues to 116' in massive structure. 80% C. R.
116	121	"	Continuing dark, massive meta andesites to 121'.
121	126	"	40% C.R. Highly broken and dark colored meta andesites.
126	131	"	Very poor core recovery - Less than 10%. Same as above.
131	136	"	No. C. R.
136	141	AX	Less than 5% C. R. Highly broken meta andesites.

Docket No. DMTA-8512
Contract No. I4n-4457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log-Hole #3
Strike N 70° W, Dip 30°

Feet From	To	Core Size	Description
141	146	AX	Poor core recovery, some mineralization showing in meta andesites.
146	151	"	Soft sandy material showing with small pieces of ore. Country highly broken. Very poor core recovery.
151	161	"	10% C. R. Schistosed structure with considerable mineralization, highly broken up.
161	166	"	Alteration to grey to reddish material sandy in structure. 50% C. R.
166	171	"	Continuing soft broken up material, reddish and grey mixture to bottom of hole.

Diamond Drill Log - Hole #4
Strike N 70°W - Dip -45°

0	6	NX	Overburden
6	10	"	80% C.R. General ore zone, core solid.
10	16	"	Same as above, solid formation 100% C. R.
16	23	"	General ore zone continuing. Broken up country at 21' to 22'. 100% C. R.
23	30	"	Ore zone continuing to 26' where alteration to meta volcanics occurs with some mineralization. 60% C. R.
30	36	BX	80% C. R. Ore zone at 30', continuing-36'.
36	39	"	36'-37', Brecciated material with schistosity, 37'-39' alteration back to ore zone. 80% C. R.
39	44.5	"	Ore zone continuing to 43', quite broken up. Alteration at 43' to very dark meta volcanics. 70% C. R.
44.5	49	"	90% C. R. Continuing dark meta volcanics, solid formation.
49	53	"	Continuing meta volcanics to 50' where country is broken and lighter in color. Alteration at 51 to green Al-Si minerals.
53	59	"	20% C. R. Ore continuing to 54' where shaly or slaty structure occurs, light ground mass, some mineralization.
59	64	"	Broken up country to 61', loose material showing some ore. 61-64', badly broken up schistose structure. 80% C. R.
64	76	"	Alteration to dark slaty shale at 69' which continues to 70' where material is of massive dark meta andesites, which continues to 76'. 40% C. R.
76	80	"	Continuing dark meta andesites which continue to 75'. 80% C. R.
80	83	"	Same as above. 75% C. R.
83	86	"	Considerable quartz showing in dark meta andesites, also porphrytic structure with some feldspars scattered throughout. 75% C. R.
86	91	"	100% C. R. Dark meta andesites, solid formation.
91	96	"	100% C. R. Same as above. No mineralization.

Docket No. DVEA-2512
Contract No. Idm-5457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole #4
Strike N 70°W - Dip -45°

Feet From	To	Core Size	Description
96	102	BX	90% C. R. Same as above.
102	107	"	Continuing dark meta andesites with small phenocrysts. 100% C. R.
107	109	"	75% C. R. Same as above except for occasional quartz seams.
109	114	"	80% C. R.
114	120	"	Same as above, 90% C. R.
120	125	"	Same as above, 50% C. R.
125	128	"	Broken up country beginning at 127'. Lighter ground mass. 50% C. R.
128	134	"	Schistosed structure, some mineralization. 50% C. R.
134	139	"	5% C. R. Broken up country, light ground mass.
139	145	"	30% C. R. Ore showing at 139' which continues to 145', low grade.
145	147'	AX	80% C. R. Some mineralization continuing to 147' in dark ground mass.
147	150'	"	50% C. R. Broken up country, some mineralization, dark in color.
150	156'	"	20% C. R. Very badly broken, dark, material. Meta andesite
156	160	"	40% C. R. Formation more solid, dark meta andesite.
160	165	"	20% C. R. Same as above.
165	170	"	Poor C. R. Same as above with slight mineralization.
170	175	"	50% C. R. Continuing predominance of meta andesites with slight mineralization.
175	180	"	10% C.R. Same as above.
180	185	"	Dark meta andesite, badly broken, 20% C. R.
185	190	"	Same as above. Poor C. R.
190	195	"	40% C. R. Formation more solid. Black meta andesite.
195	200	"	Same as above with some mineralization. 40% C. R.

Diamond Drill Log - Hole #5
Strike N 70°W - Dip -45°

3	11	NX	Solid formation, general ore zone, light in color with green AlSi minerals throughout. 65% C. R.
11	16	"	90% C. R. Ore zone continuing, appears to be lower in grade up to 16'. Very solid formation.
16	21	"	20% C. R. Alteration at 16', siliceous structure. Light ground mass. Highly broken up.
21	26	"	Country not quite so broken, some schistosed structure. 25% C. R.
26	28.5	"	Formation solid; highly siliceous at 26' mineralization increasing to general ore zone at 28'. 90% C. R.
28.5	31	"	General ore zone, solid core, slightly darker in color. 80% C. R.
31	35	"	Highly broken up country, schistosed structure, with abundant green AlSi minerals. 10% C.R.
35	41	"	Formation more solid- at 35'-36'. General ore zone-broken up from 36'41', quartz seam at 40-41'. Broken up country. 60% C. R.

Docket No. DMEA-2512
Contract No. Idm-2457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole #8
Strike N 70°W - Dip -45°

Feet From	Feet To	Core Size	Description
41	46	NX	Schistosed structure at 41' continuing, 44'. General ore zone, 44-46' ore zone formation more solid. Some oxidized surfaces. 60% C.R.
46	51	"	Broken up ore zone, 46-47'. Formation solid from 47-51'. General ore zone continuing to 51', good quality. 100% C. R.
51	56	"	General ore zone continuing. Country more broken up which continues to 52'. Formation solid from 52'-56'. General ore zone. 60% C. R.
56	59	"	At 56-57' slight change in structure, highly iron stained ore zone. Formation solid and ore zone continues. Blue green cast. 100% C.R
61	66	BX	General ore zone continuing, unusual mineralization at 62'. Light in color with off color green veinlets. Countrymore broken up. 60% C. R.
66	71	"	General ore zone continuing. Solid formation. 100% C. R.
71	75.5	"	80% C. R. Same as above.
75.5	81	"	Same as above. 70% C. R. Country somewhat broken.
81	86	"	Ore more quartzite at 81' increasing in quality up to 86'. 70% C. R.
86	91	"	Low grade ore to 91'. Country somewhat broken with quartz seam interruption. 60% C. R.
91	93	"	Some character ore to 93'. 75% C. R. Buff in color.
93	95	"	Ore zone, low in grade. Quite siliceous. Small crystals of meta volcanics shot through. 75% C. R.
95	10[illegible]	"	General ore zone. Quite siliceous, appearing to be higher in grade. 70% C. R.
100	105	"	70% C. R. Better grade ore zone continuing up to 105'.
105	108	"	50% C. R. Continuing ore zone.
108	111	"	40% C. R. Same as above.
111	114	"	Ore continues solid to 114' where alteration takes place to grey meta andesites. 30% C.R.
114	117	"	Meta andesites continuing to 116' where alteration takes place to general ore zone, darker in color, reddish. Continues to 117', 70% C.R.
117	120	"	50% C. R. Continuing ore zone. Reddish in color, somewhat broken up.
120	124	"	Ore zone continuing to 124'. Lighter in color to 122' and darker from 122-124'. 80% C. R.
124	127	"	General ore zone continuing-127' lower in grade from 126-127'. 100% C. R.
127	132	"	Somewhat siliceous ore to 128'. Very solid core from 128-131'. General ore zone. 100% C. R.
132	136	"	75% C. R. Low grade ore zone. Formation solid. Quite siliceous in appearance.
136	139	"	Same as above. 70% C. R.
139	142	"	80% C. R. Same as above.
142	146	"	50% C.R. Same as above, except darker in color.
146	151	"	Ore zone, lighter in color, 10% C. R.
151	153	"	20% C. R. Pinty ore structure broken.

Docket No. DMEA-2812
Contract No. Idm-5457

Bismark Mine
Mineral County, Nevada

Diamond Drill Log - Hole #5
Strike N 70°W - Dip -45°

Feet From	To	Core Size	Description
156	161	BX	Broken up country-general ore zone. 20% C. R. Low in grade; more massive.
161	166	"	Same as above.
166	171	"	10%. Same as above. Platy structure.
[illegible]	176	"	Alteration at 171' to schistosed ore structure low in quality. Poor core recovery.
176	179'	"	P. C. R. Highly schistosed structure. Bottom of hole.

FORM 407

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881

PITTSBURGH, PA.

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ORDER No. SF 657 651 Howard St. San Francisco LABORATORY No.

CLIENT'S No. FILE No.

REPORT

September 28, 1953

Coranda Corporation
386 Race Street
San Jose, California

Attention: Mr. J. H. Fodda, President

Subject: Four (4) Pyrometric Cone Tests

Sample	P.C.E.
L-343-1	37-38
L-343-1 Calcined	37-38
L-343-2	38
L-343-2 Calcined	38

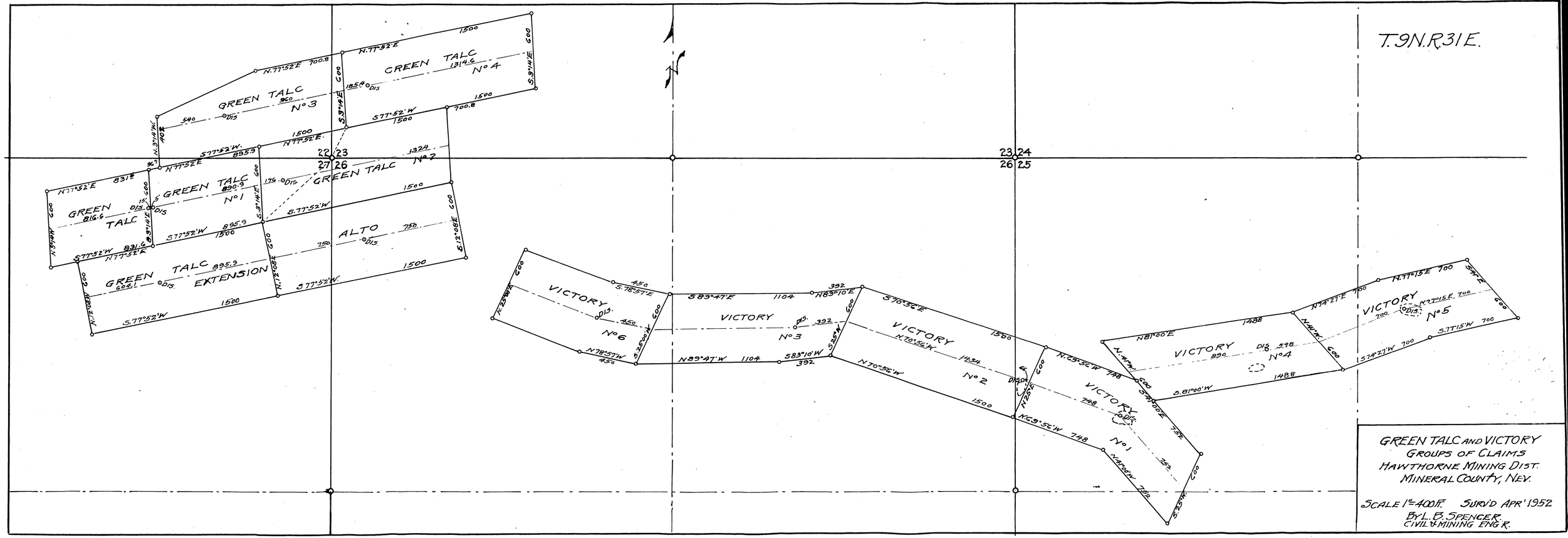
Respectfully submitted,

PITTSBURGH TESTING LABORATORY

Chas. W. Robinson

District Manager

WWC
SS
bk
cc: 10 - above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ALTO
VICTORY
N°6
VICTORY
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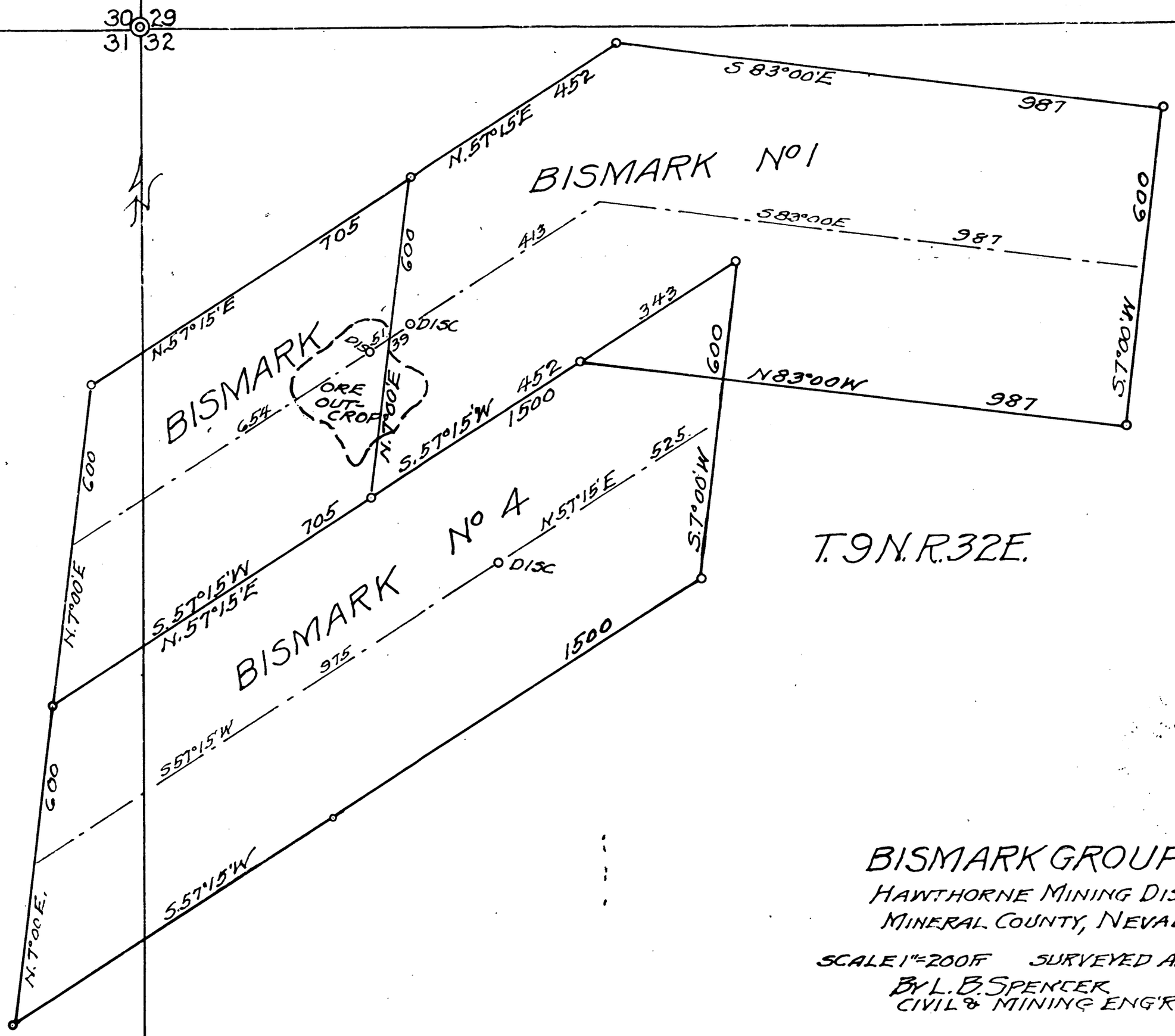
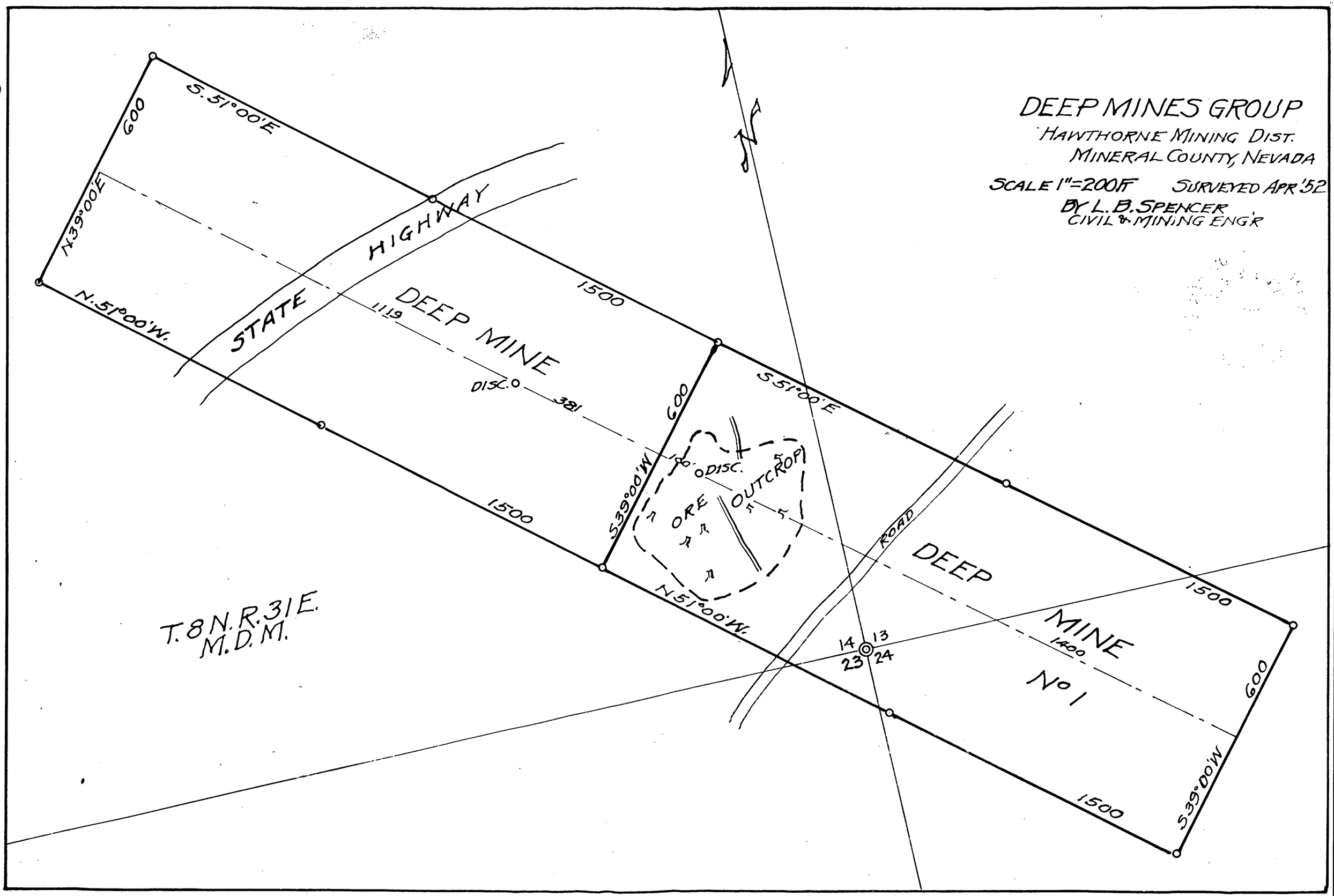
VICTORY
N°2
VICTORY
N°1
VICTORY
N°4
VICTORY
N°5
22 23
27 26
23 24
26 25
GREEN TALC AND VICTORY
GROUPS OF CLAIMS
HAWTHORNE MINING DIST.
MINERAL COUNTY, NEV.
SCALE 1"=400 FT. SURV'D APR' 1952
BY L. B. SPENCER.
CIVIL & MINING ENG'R.



T.9N.R.32E.

BISMARK GROUP
HAWTHORNE MINING DIST.
MINERAL COUNTY, NEVADA

SCALE 1"=200FT SURVEYED APR. '52
BY L. B. SPENCER
CIVIL & MINING ENG'R.


DEEP MINES GROUP
HAWTHORNE MINING DIST.
MINERAL COUNTY, NEVADA
SCALE 1"=200FT
SURVEYED APR '52
BY L. B. SPENCER
CIVIL & MINING ENG'R
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0 DISC.
ORE
OUTCROP
ROAD
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N.51°00'W.
DEEP
MINE
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24
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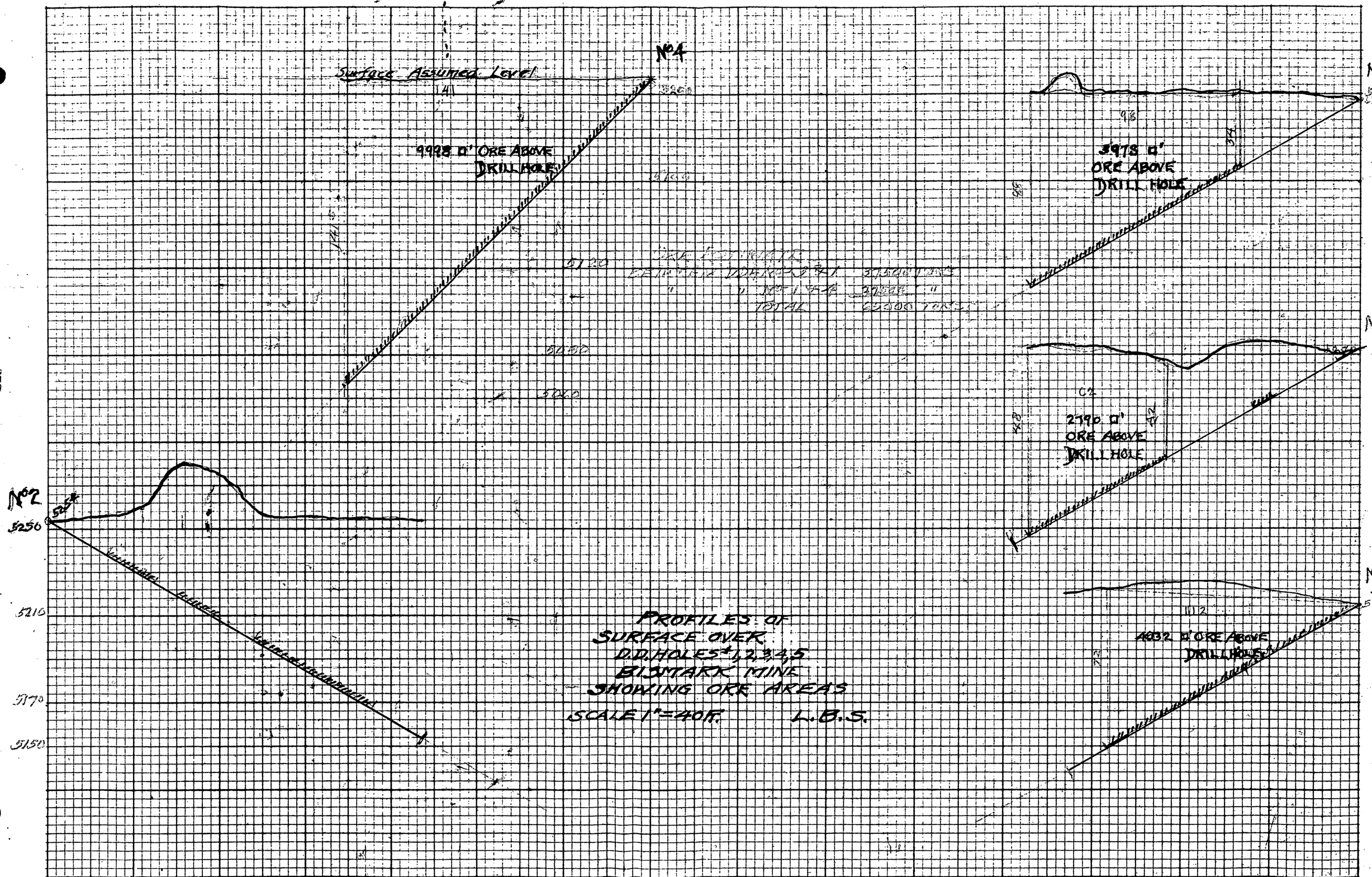
M.D.M.



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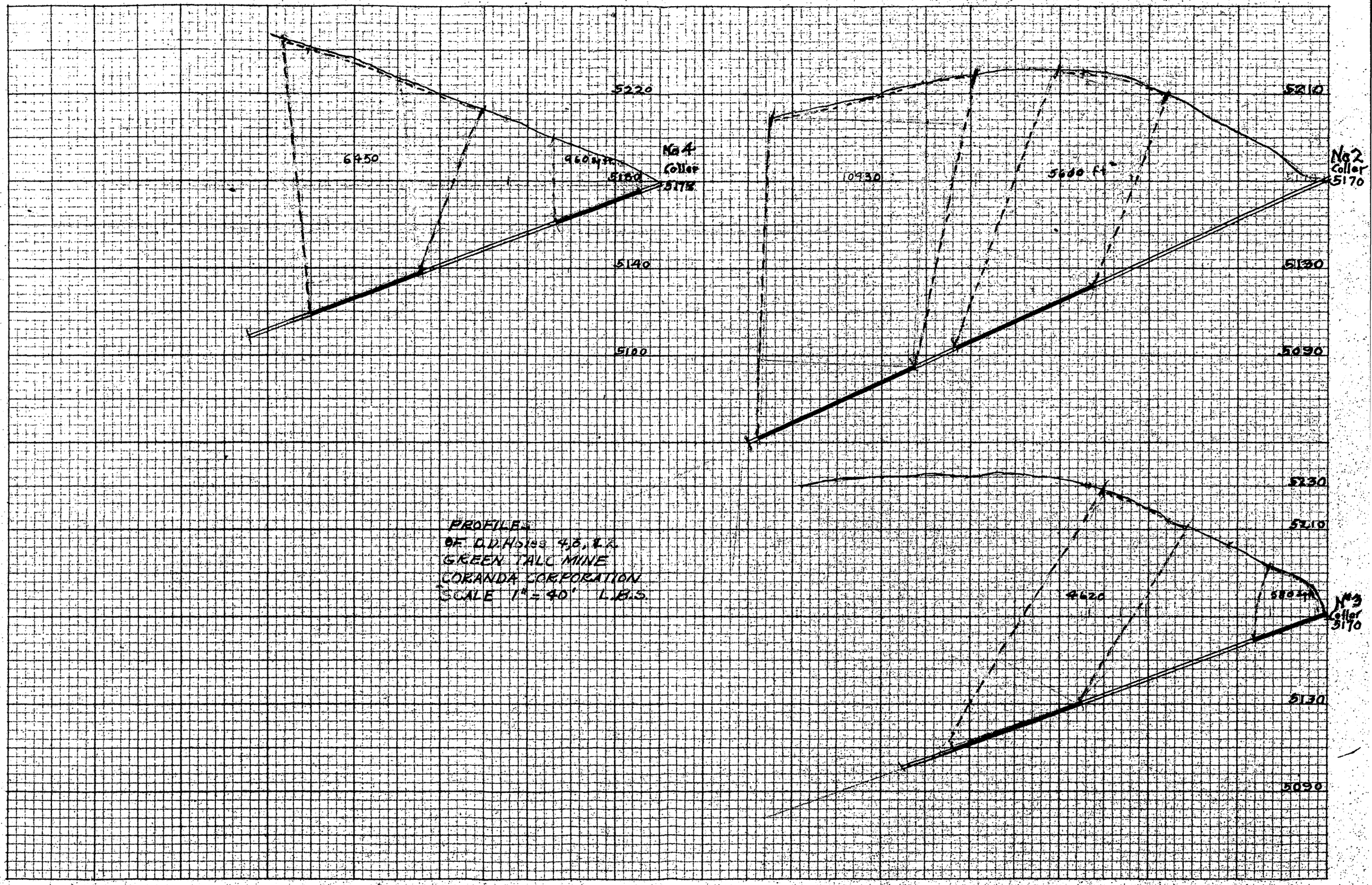

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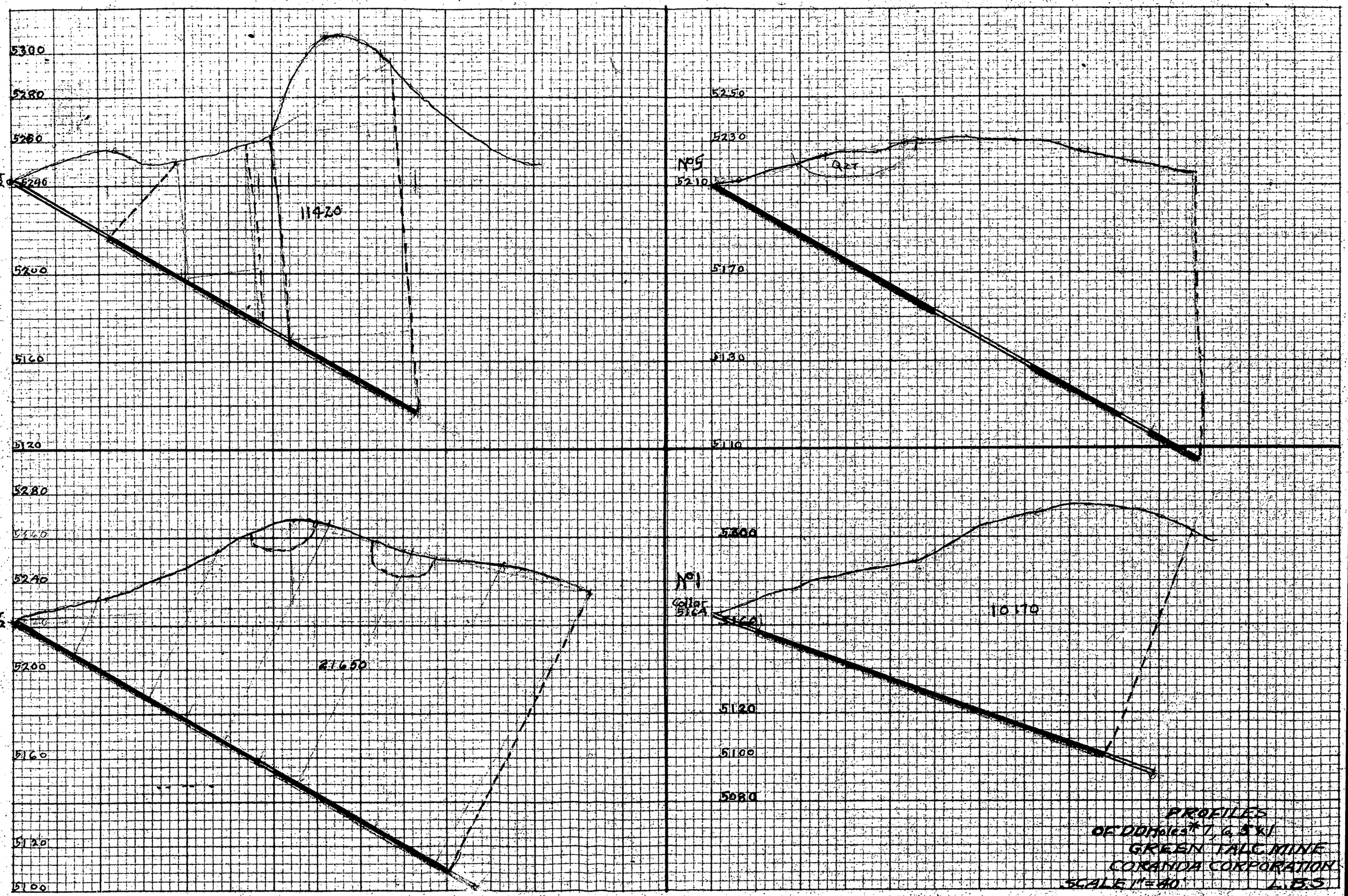

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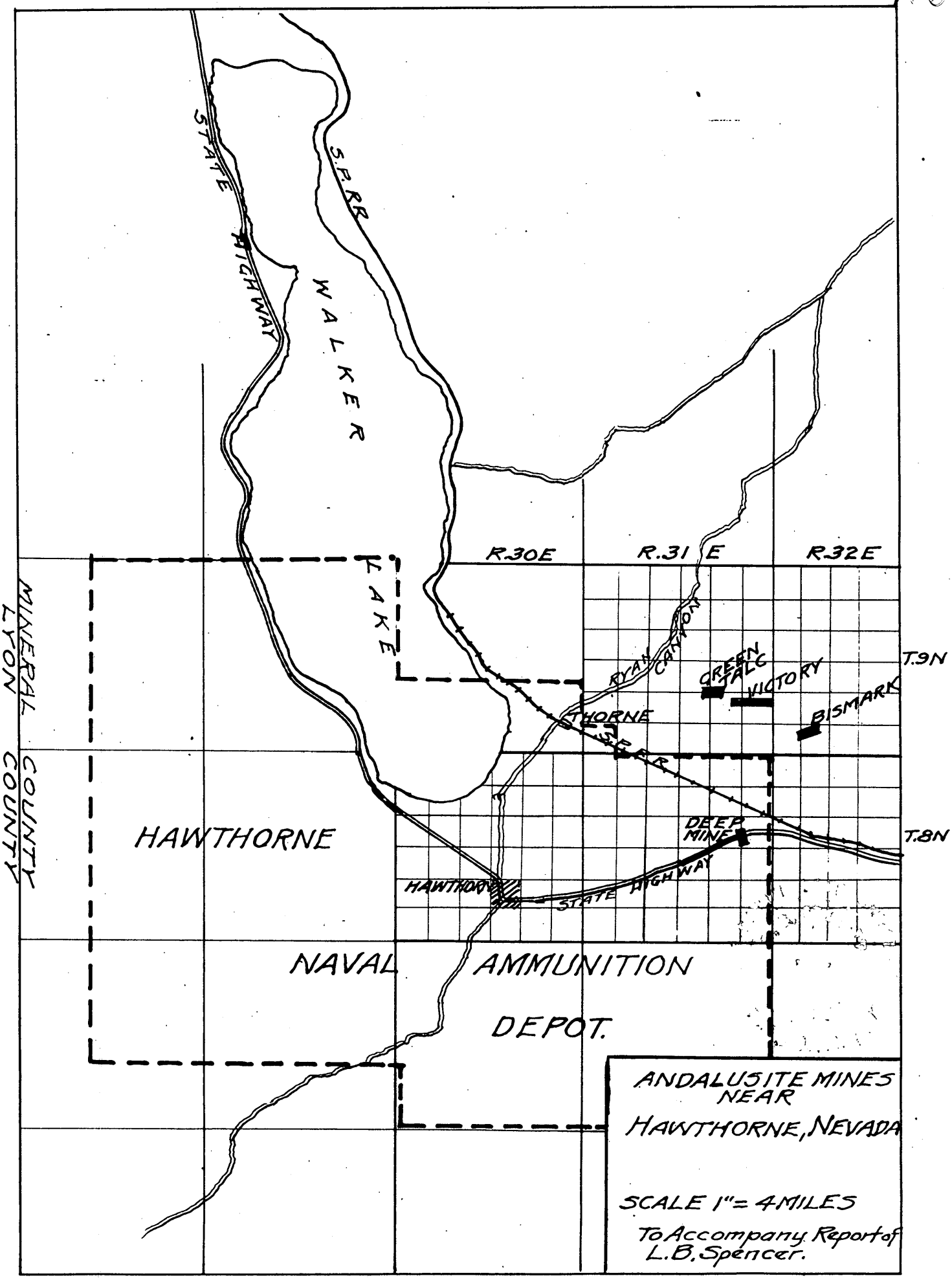
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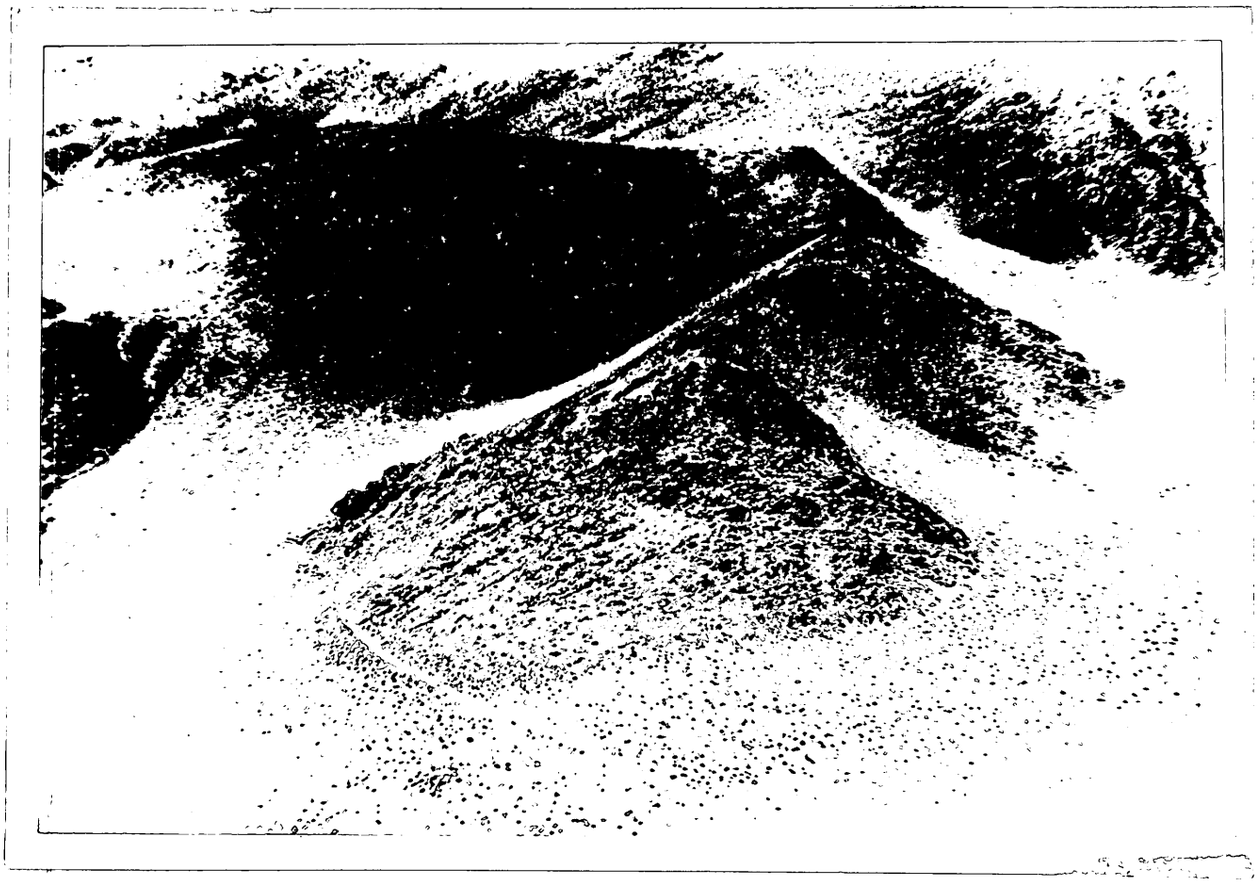
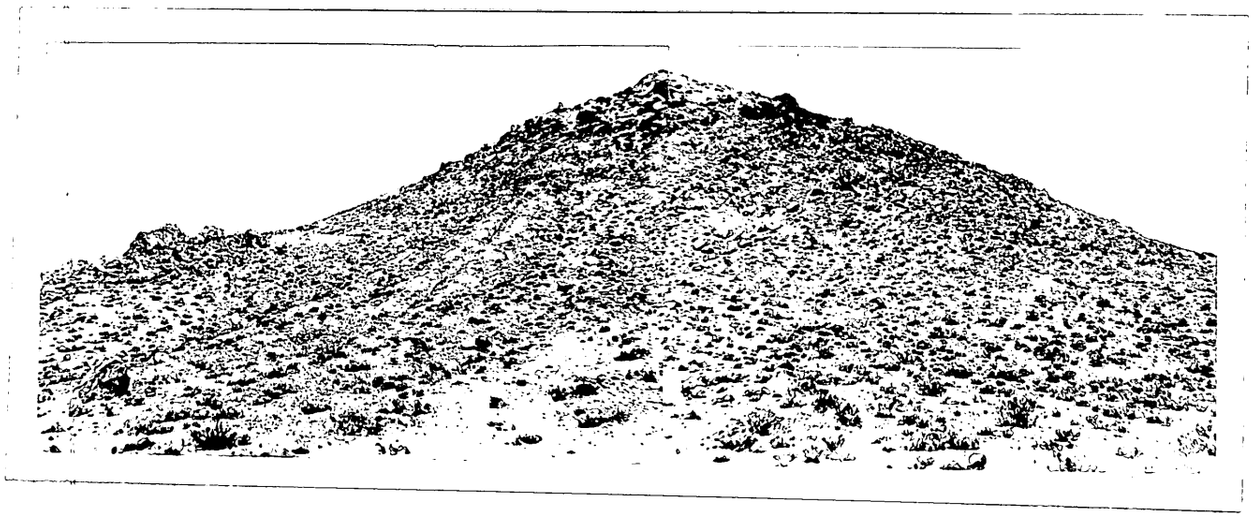
WALKER
LAKE
R.30E
R.31 E
R.32E
T.9N
T.8N
RYAN CANYON
GREEN TALC
VICTORY
BISMARK
THORNE
S.P.R.R.
DEEP MINE
HAWTHORNE
STATE HIGHWAY
HAWTHORNE
NAVAL AMMUNITION DEPOT.
MINERAL COUNTY
LYON COUNTY
ANDALUSITE MINES NEAR HAWTHORNE, NEVADA
SCALE 1" = 4 MILES
To Accompany Report of L.B. Spencer.



1. Looking to North West on Bismark Claims. Outcrop in picture 2 shows at end of road to left of central hill. White spot on top of hill part of ore bearing structure strike extends left to right over hill.

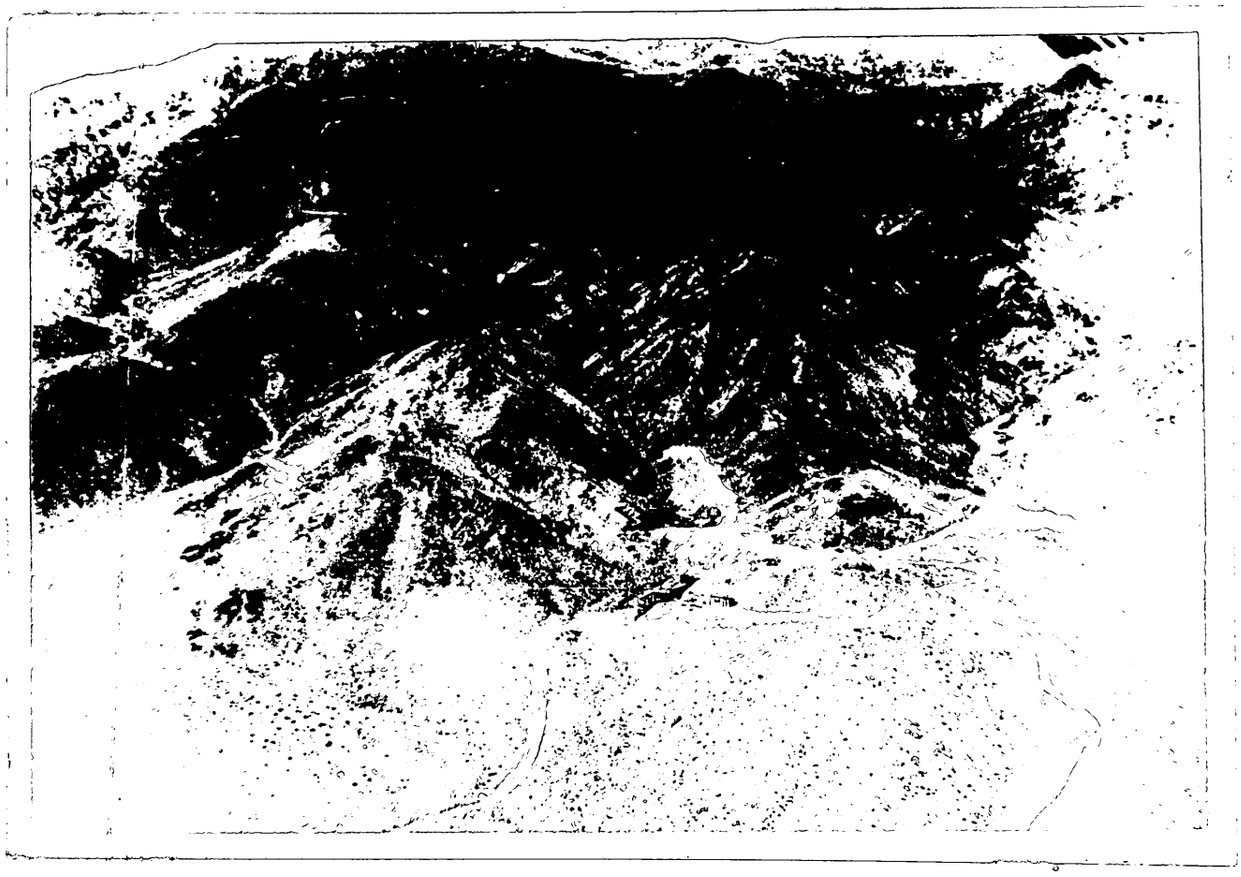
2. Outcrop on Bismark Claim Group looking East along strike of structure.

3. Extension of geologic structure to West on the Bismark Claims.

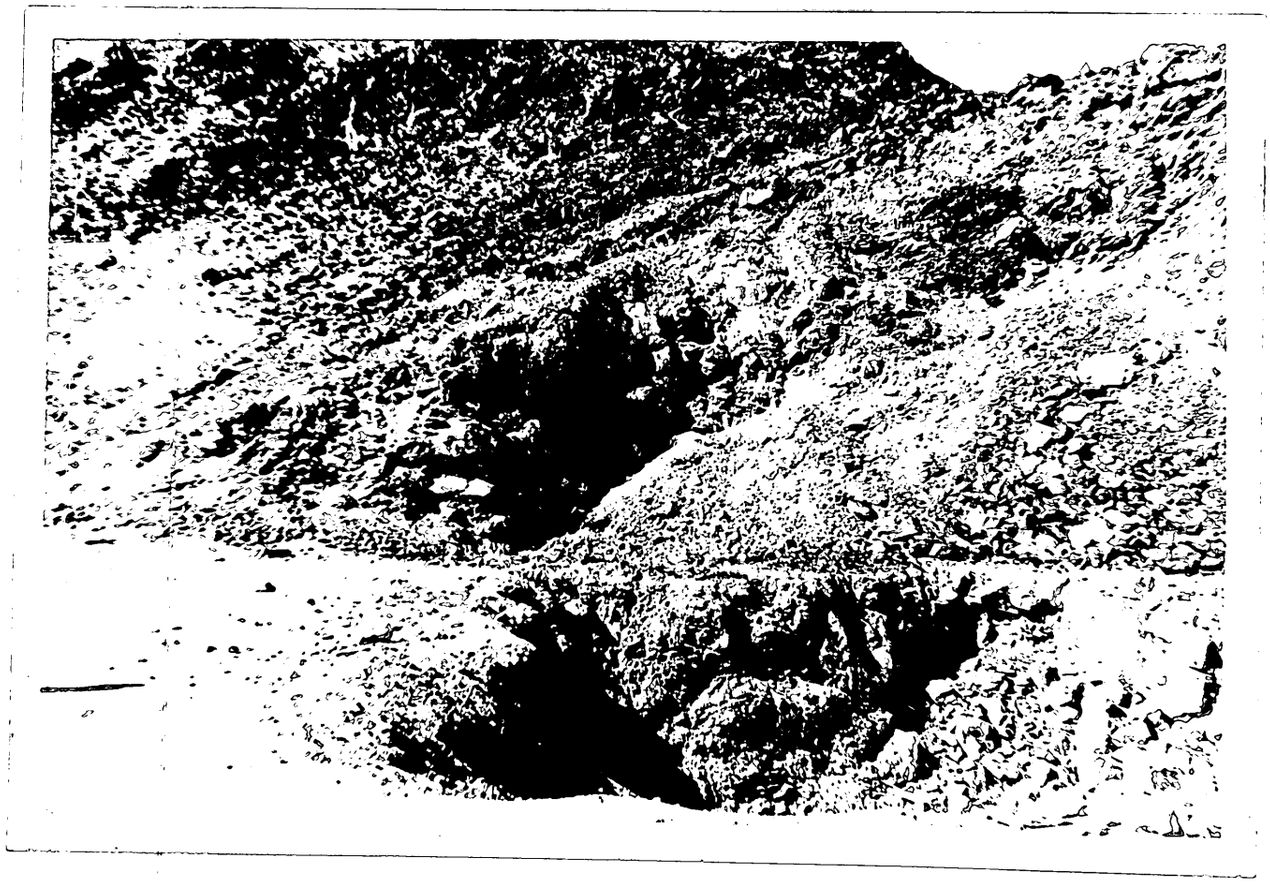


4. Panorama of Deep Mine outcrops looking North. Starting at the left working, the upper limit of the ore zone extends through the lower third of the vertical trench and rises to the upper right working and curves upward to the dark patch of rocks near the top right of the hill. It is reported that the ore zone extends beyond the lower limits of the picture.

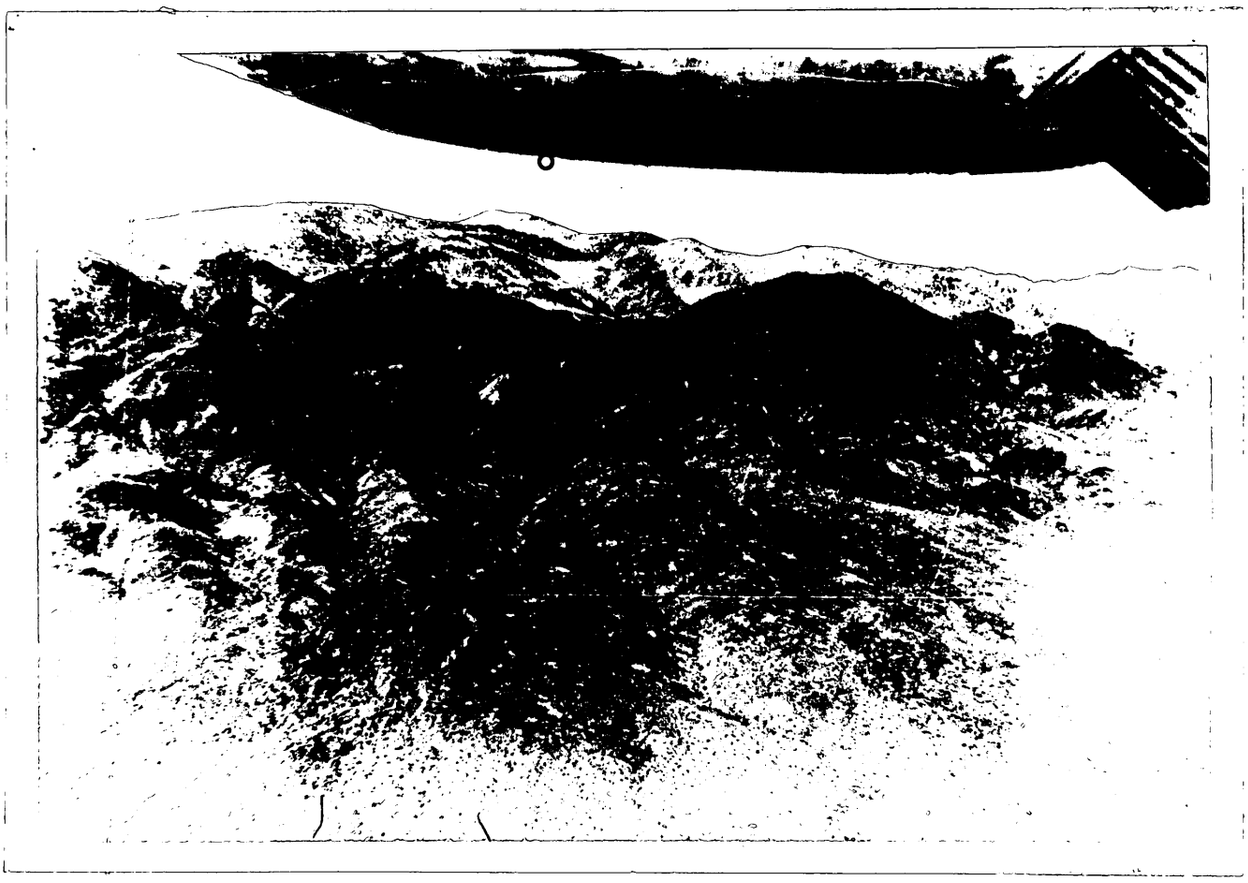
5. Crest of hill on Deep Mine Claims part of this outcrop contains ore.



6. Green Talc Claims looking North, open cut in Picture 7 to the right over buildings.



7. Open cut on Green Talc Claims showing typical ore contacts.



8. General view looking North on Victory Claims.

UNITED STATES DEPARTMENT OF THE INTERIOR,
Harold L. Ickes, Secretary

BUREAU OF MINES
R. R. Sayers, Director

War Minerals Report 363

PRELIMINARY PILOT-PLANT CONCENTRATION OF ANDALUSITE-CORUNDUM ORE FROM THE VICINITY OF HAWTHORNE, NEV.

WASHINGTON: 1937

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PRELIMINARY PILOT-PLANT CONCENTRATION OF ANDALUSITE-CORUNDUM ORE FROM THE VICINITY OF HAWTHORNE, NEV.[1]

SUMMARY

The far-western area of the United States has relatively few developed deposits of minerals containing enough alumina to be used for the manufacture of high-alumina furnace refractories. The andalusite ore in the Hawthorne deposit is not sufficiently uniform to meet market specifications for refractory purposes, but it is possible that the ore may be beneficiated so as to produce a satisfactory concentrate. Preliminary tests have indicated that gravity concentration would produce the highest-grade product and would represent the simplest method of treatment.

Pilot-plant tabling tests were made on about 50 tons of ore that analyzed 42.5 percent Al_2O_3 and 54.2 percent SiO_2. Three flow sheets were used, each varying slightly in grinding and sizing procedure; 15 different concentrates were produced, which varied in grade from 52.1 to 72.4 percent Al_2O_3 and 44.9 to 25.2 percent SiO_2, the composited average being 62.3 percent Al_2O_3 and 35.1 percent SiO_2; the over-all ratio of concentration was 4.2 to 1. One special corundum concentrate containing 91.5 percent Al_2O_3 was made in addition.

The final value of the concentrates to the refractory industry will be determined by further large-scale tests conducted cooperatively by Pacific-coast refractory producers who will mix the concentrate with clay in an attempt to produce a super-duty fire brick.

INTRODUCTION

Modern industry steadily is increasing its demands for furnace refractories that possess a combination of high mechanical strength, low porosity and shrinkage, and resistance to abrasion at high temperatures. In many instances these demands have been fulfilled best by high-alumina refractories composed predominantly of the artificial mineral compound mullite, $3Al_2O_3 \cdot 2SiO_2$. Mullite is a product formed by the interaction of

1 By C. T. Baroch, ass't. supervising engineer; H. D. Snedden and V. R. Homme, associate metallurgists; and E. T. Schrenk, assistant mineralogist, Bureau of Mines.

silica and alumina in correct proportions at relatively high firing temperatures or may be obtained as a transition product of the decomposition of minerals of the kyanite group (andalusite, kyanite, and sillimanite) at high temperatures.

High-alumina refractories are neutral, and they flux or form slags with difficulty; consequently, they are used widely in lead and glass furnaces, clinker-zone linings in Portland cement kilns, in boiler-furnace settings used for high-ash coals, and in blast-furnace regenerators. A list of pyrometric cone equivalent values and chemical analyses of various grades of typical high-alumina brick are given in table 1.[2]

TABLE 1. - Typical analyses of high-alumina refractories

High alumina, class	Analysis, percent			
	50	60	70	80
Al_2O_3	51.5	60.8	70.6	79.4
SiO_2	41.9	33.3	22.8	15.8
TiO_2	2.7	3.0	3.7	2.1
Fe_2O_3	1.8	1.7	1.8	1.7
CaO	.1	.2	.2	.2
MgO	.5	.3	.3	.3
Alkalies	1.2	1.1	1.0	1.0
P.C.E., cone number	34-35	36-37	38	39
Temperature equivalent, °C	1,773	1,815	1,835	1,865

Specifications for marketable andalusite require a product containing 60 to 65 percent Al_2O_3; it is sold frequently on the basis of a specific gravity ranging between 3.05 and 3.15. The Hawthorne deposits are not directly marketable as an andalusite of refractory grade, because most of the ore contains only 40 to 50 percent Al_2O_3.

Preliminary concentration tests made at the ore-testing laboratories of the Bureau of Mines, Salt Lake City, Utah, early in 1943 included gravity separation by "sink-float;" jigging and tabling methods on minus 1/2-inch, 3-mesh, and 35-mesh ore; electrostatic and electromagnetic separation on gravity separation products; and flotation with fatty acids, cationic reagents, and alcohols at high, intermediate, and low pH values.

Conclusions reached by the laboratory work showed that Hawthorne andalusite ore could be beneficiated as follows:

1. By table concentration of ore ground to minus 48-mesh and sized; 66.0 percent of the alumina was recovered in a product containing 63.2 percent Al_2O_3 and 35.8 percent SiO_2.

2. By cationic flotation of silica from ore ground to minus 100-mesh; 71.3 percent of the alumina was recovered in a product containing 60.0 percent Al_2O_3 and 39.4 percent SiO_2.

3. By fatty-acid flotation of ore ground to minus 100-mesh; 54.7 percent of the alumina was recovered in a product containing 60.7 percent Al_2O_3 and 37.8 percent SiO_2.

2 Bochow, W. R., Properties and Applications of Modern Refractories: Chem. and Met. Eng., vol. 42, 1935, p. 76.

Gravity concentration gave the highest-grade product and represents the simplest method of treatment; therefore, it appears to be the preferable method.

The value of clays and other minerals for refractory purposes can not be determined solely by chemical analyses, as many physical attributes of the materials and variations of processing techniques enter into the quality of a refractory. Consequently, it became apparent early in the investigation that the ultimate use-value of Hawthorne concentrates could be determined only by trial firings. This meant that a sizable quantity of concentrates would be required; therefore, 59 tons of the ore was shipped to the Boulder City, Nev., pilot plant. This ore was treated by table concentration, and concentrates were made in small lots of different grades and particle sizes for subsequent use in refractory firing tests. The refractory test work probably will be performed partly under cooperative agreements with Pacific-coast refractory manufacturers and partly by Bureau of Mines specialists in nonmetallic minerals.

DESCRIPTION OF THE ORE

The ore deposits are in the southern foothills of the Gillis Range about 10 miles northeast of Hawthorne, Mineral County, Nev. The Federal Geological Survey reports five groups of claims in the district. They are the Green Talc, Dover, Bismarck, Victory, and Deep Mines. The Bureau of Mines has made ore-dressing tests on samples from two of the groups - the Green Talc, controlled by William Rae and John Buich, and the Dover, controlled by B. H. Donnelly and associates. The original (Eriksen) sample tested by the Bureau of Mines is reported by Donnelly to be from his property. The sample treated in the Boulder City pilot mill was taken from the Green Talc group of claims.

Reserves

Little developing has been done, and no mineral reserve has been technically blocked in any of the deposits. Tonnage estimates of inferred mineral are based upon surface outcrops assumed to extend to a depth of 100 feet.

Green Talc group. - The main outcrop is approximately 800 by 200 feet in surface area. If assumed to extend to 100 feet in depth and to be of milling grade, 1,300,000 tons of inferred material is indicated.

Dover group. - No tonnage estimates can be made of mineral in this group because of surface overburden and insufficient development.

Deep Mines group. - Andalusite and associated aluminum silicate minerals outcrop over an area 300 by 300 feet. If mineralization is assumed to extend for a depth of 100 feet, 750,000 tons of milling-grade material may exist.

Victory group. - No mineral other than float has been found on this group. It was located recently and no work has yet been done.

Bismarck group. - Aluminum silicate minerals outcrop over an area 50 by 150 feet. If this deposit is assumed to extend to a depth of 100 feet, 62,500 tons of milling-grade minerals might be produced.

Estimated inferred mineral

	Tons
Green Talc group	1,300,000
Deep Mines group	750,000
Bismarck group	62,500
	2,112,500
Less 40 percent estimated for inclusions of dikes, quartzite, and submarginal material	845,000
Net	1,267,500

Submarginal mineral is that having a specific gravity less than 2.9.

The 59 tons of ore received for the test arrived in two truck-and-trailer shipments. The ore of the first truckload was characterized by large, conspicuous masses and veins of green sericite; the ore in the second shipment carried green sericite in small veins only. In general, the material is fine-grained, dense, and quite hard; it is gray to grayish-blue in color except in the zones or veins, in which the pale-green sericite predominates.

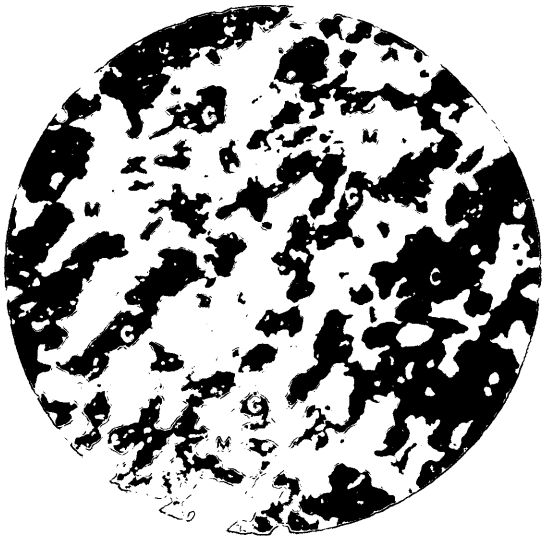
The rock appears to have been formed by contact metamorphism brought about by an igneous intrusion into argillaceous country rock and subsequently altered by hydrothermal action.

The principal minerals identified in thin sections include:

1. Andalusite. - Al_2SiO_5; specific gravity 3.16; hardness 7.5; usually breaks into prisms showing cleavage in one or two directions and an uneven fracture; changes to mullite at about 1,350° C. The andalusite in this ore is pale cream to milky white in color. It occurs chiefly as small crystals and remnants of crystals disseminated throughout the rock or occasionally as coarse crystals concentrated in short, thick, lenslike masses. In addition, all of the pale-green sericite veinlets examined contain small crystals of andalusite, typically shown in figure 1. Inclusions of sericite are common within individual andalusite crystals, and it appears that much of the original andalusite has been altered to sericite.

2. Corundum. - Al_2O_3; specific gravity 3.95-4.10; hardness 9; usually breaks into grains having irregular cleavage and uneven to conchoidal fracture; melting point, 2,050° C. Most of the corundum in this ore is deep blue in color, but some varies to almost white. It is disseminated throughout the ore, but areas of concentrated granular corundum are not uncommon. The crystals are very small, show inclusions of mica or mica-like minerals, and occur singly or in small clusters typically as shown in figure 2.

1



2

A - andalusite
C - corundum
Q - quartz
M - mica

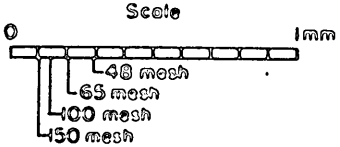


FIGURE 1.- Green sericite veinlet adjacent to andalusite crystals. Polarized light.
FIGURE 2.- Average gray-blue mottled ore. Corundum crystals in a groundmass of sericite. Plane light.

3. Mica. - Variable in composition but essentially acid salts of orthosilicic acid or acid aluminosilicate; specific gravity 2.7; hardness 2-2.25. Muscovite (potassium micas), sericite (fine-grained muscovite), and perhaps some paragonite (sodium mica) are present in the Hawthorne ore. Small books of muscovite were noted, but these are not abundant. However, sericite is abundant and occurs intimately mixed with the andalusite and corundum or independently in pale-green veinlets. Chemical analyses of selected material indicate that if the soda mica, paragonite, $H_2NaAl_3(SiO_4)_3$, is present, it is minor as compared to sericite, and that the sericite is low in potash, as shown in table 2.

TABLE 2. - Chemical analysis of pale-green sericite

	Percent		Percent
Al_2O_3	38.40	MgO	0.65
SiO_2	47.19	CaO	.28
Fe_2O_3	.32	TiO_2	.10
K_2O	8.18	B.	.08
Na_2O	.76	L.O.I.	4.32

4. Quartz. - SiO_2; specific gravity, 2.5; hardness, 7. Quartz is present throughout all of this material as very small anhedral crystals or else as small, rounded grains up to 0.2 mm. in diameter. It is most abundant as small anhedral grains associated with the sericite.

5. Pyrophyllite. - $H_2Al_2(SiO_3)_4$; specific gravity, 2.8-9; hardness, 1-2. One mica-like constituent of the ore was identified by X-ray and chemical analyses as pyrophyllite. The chemical and physical similarities of this mineral and mica prevent quantitative determination of either when both are present in an ore.

Several accessory minerals, including titanite, magnetite, and hematite, were noted in the thin sections, but their percentage is small. A chemical analysis of the ore is given in table 3.

TABLE 3. - Chemical analysis of ore

	Percent		Percent
Al_2O_3	42.50	Fe_2O_3	0.42
SiO_2	54.20	TiO_2	.77
K_2O	.73	Fe_m*	.12
Na_2O	.29	L.O.I., 800° C.	2.13

*Metallic iron from grinding.

Mineralogical analyses were made by using two different techniques on representative portions of the ore, the first at the Boulder City station and the second at the Salt Lake station.

The first mineralogical analysis was made by using a combination of heavy-liquid separation and interpretation of chemical analysis. To assure accuracy, several tests were made and each product was examined under

the petrographic microscope. Assuming that quartz, combined silica (mica), corundum, and andalusite are the variables in this ore, the percentage of minerals can be calculated from the chemical analysis if the percentage of corundum is known. Corundum was determined by separation with the heavy liquid methylene iodide, specific gravity 3.325, using a sample ground to pass a 150-mesh screen. The quantity of mica was calculated from the K_2O and Na_2O determined by chemical analysis, but insufficient alkali was present to account for the percentage of micas actually observed with the microscope. It is possible that pyrophyllite, $Al_2O_3 \cdot 4SiO_2 \cdot H_2O$, may be present and that it has been mistaken for sericite, because the optical properties of these two minerals are very similar.[3] If pyrophyllite is present in large amounts correct interpretation of chemical analyses is impossible, because andalusite and pyrophyllite are so closely related chemically and because heavy-liquid separation of pyrophyllite from sericite is not practical. Furthermore, if pyrophyllite is present, the percentage of andalusite and quartz must be reduced. The results of this analysis is given in table 4, column I.

The second mineralogical analysis was made by microscopic grain count on closely sized and carefully split fractions of the ore, using oils of varying refractive indices to distinguish the various minerals. Corundum was the only mineral identified above the index of refraction of 1.7400. The micaceous minerals and quartz were all found to be below the index of refraction of 1.6031, and all the material above this index was considered to be either andalusite or corundum. A microscopic count was then made on the same fractions, using an oil with an index of refraction of 1.7400, and all the material having a higher index was assumed to be corundum. The sample, ground to minus 100-mesh, was sized into eight products by screening and elutriation, and each fraction was weighed. A statistical count of each mineral type was taken on 500 grains in each fraction. The weighted average of the microscopic counts, which represents the volume of the different minerals, was transposed to weight percentage by assuming the gangue to have a specific gravity of 2.8, the andalusite 3.1, and the corundum 3.8. The results are given in table 4, column II.

TABLE 4. - Estimated mineral analysis of heads, specific gravity 2.95

	Weight, percent	
	I	II
Andalusite	30-35	20
Corundum	15-20	20
Mica	20-30	-
Quartz	20-30	-
Titanite	1-2	-
Miscellaneous	5-10	-
Gangue	-	60

3 Rogers and Kerr, Optical Mineralogy, 2d ed.: McGraw-Hill Book Co., Inc., New York, 1942, p. 391.

The two methods of mineralogical analyses check well regarding the amount of corundum present, but the values for andalusite are controversial. The difference in the latter could be accounted for by the presence of pyrophyllite, which has been reported by others as being present in some samples from the Hawthorne deposits. If it was present in the test sample under consideration, it was evidently too fine-grained to be positively identified with the microscope. Other factors affecting the accuracy of any mineralogical analysis include (1) difficulty of identifying submicroscopic particles produced by grinding to obtain liberation, (2) difficulty of identifying various intermediate decomposition products that occur in the ore, (3) difficulty of obtaining a small sample for microscopic analysis that is wholly representative of the ore.

TEST PROCEDURE AND RESULTS

The original laboratory tests indicated that the valuable minerals were free only at sizes finer than 35-mesh; even finer grinding appears to be necessary to free completely the mineral particles in the ore received for the pilot-plant work. The mineral-dressing tests also showed that the determination of the point at which to make cuts on the table between concentrate, middling, and tailing is difficult because there is little difference in the appearance of these products. Some preliminary tests were made on a small laboratory table using ultraviolet light, with and without filters, and various colored and fluorescent lights, but of these, only white fluorescent light intensified the bluish color of the corundum slightly. A pale wine-colored andalusite, sized to the table feed, was added to the feed in one test to determine whether or not this would act as a guide to give a suitable indication where a separating cut might be made; the method is satisfactory, but a large amount of the colored mineral is required.

The ultimate control method adopted consisted of specific-gravity determinations and frequent vanner plaque tests on samples of the table products. The bluish corundum could be distinguished readily on the vanner; its presence could be determined in the tailings and middlings, and the operators soon learned how to appraise the approximate grade of concentrate by the relative amount of the contained blue mineral.

The difference in specific gravity between andalusite, 3.16, and the quartz-mica gangue, 2.6-2.7, is not large, and their gravity separation by tabling requires careful adjustment of feed rate and close sizing of table feed. In the pilot-plant runs, ground ore was hydraulically classified or screen sized, the coarsest fraction tabled directly, and the finer sizes stored in tanks and tabled later. The same table was used for all the classified products. Three flow sheets were used, each varying in the method of preparing and sizing table feed.

First Flow Sheet

The first pilot-mill work was conducted according to the flow sheet shown in figure 3, and a screen analysis of the ball-mill feed is given in table 5.

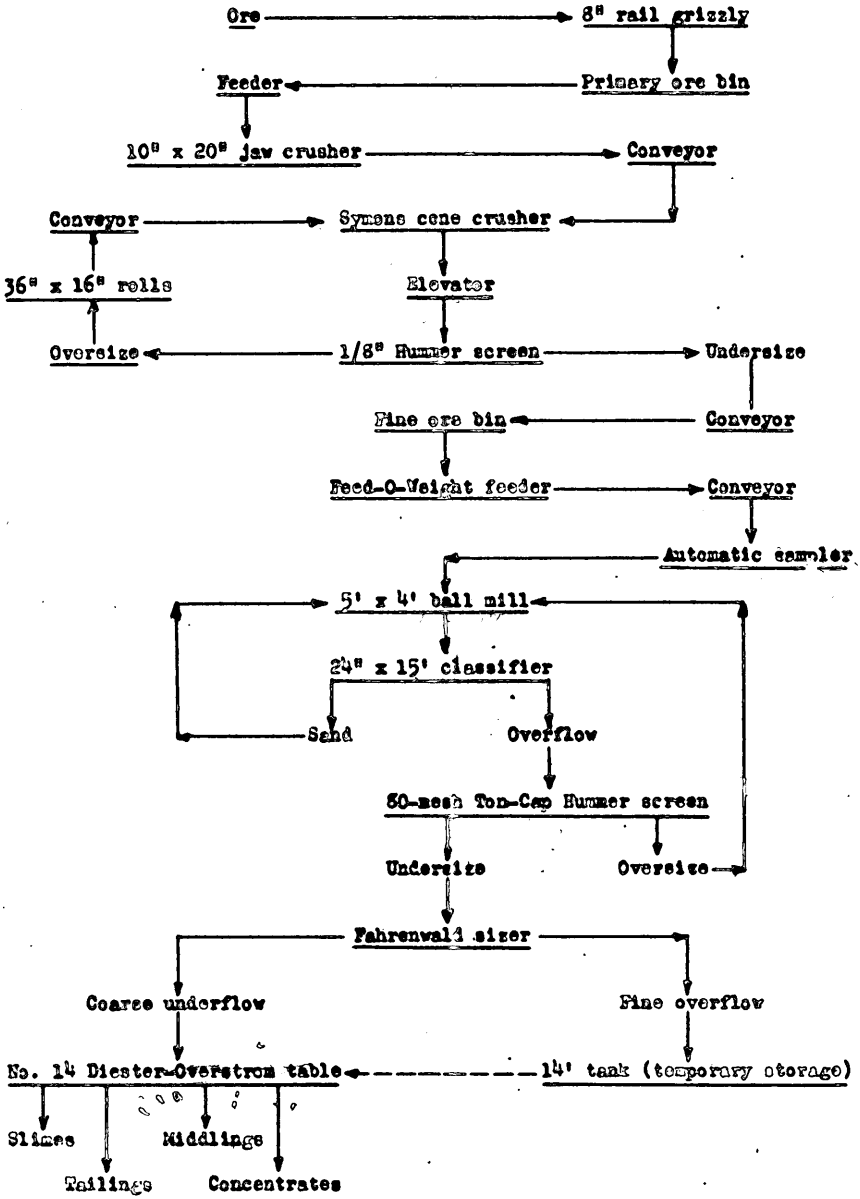


Figure 3. - First flow sheet.

TABLE 5. - Screen analyses of 1/8-inch ball mill feed

Mesh	Weight, percent	Cumulative, percent
-6+8.	15.67	15.67
-8+10	15.54	31.21
-10+14.	16.19	47.40
-14+20.	9.69	57.09
-20+28.	7.08	64.17
-28+35.	5.40	69.57
-35+48.	4.61	74.18
-48+65.	3.32	77.50
-65+100	3.71	81.21
-100+200. . . .	5.46	88.67
-200.	13.33	100.00

Fine ore was fed by means of a Merrick Feed-O-Weight constant-weight feeder, which recorded the weight of the ore. An automatic sampler cut the full stream of ore every 3 minutes. The ball mill, 5 feet in diameter by 4 feet long, was charged with 2,100 pounds of 4-inch balls, 2,250 pounds of 3-inch balls, and 650 pounds of 2-inch balls. The mill operated in closed circuit with a Dorr rake-type classifier 24 inches wide by 15 feet long, the overflow of which was pumped to a Hummer vibrating screen fitted with 80-mesh Ton-Cap sieve wire. Ball-mill feed rate was increased gradually to as high as 2,760 pounds per hour, but this is not the maximum capacity of the mill for this size feed, as very little sand was returned to the mill by the classifier. Pulp discharge from the ball mill contained 50 to 60 percent solids, and the classifier operated at 35 to 40 percent solids.

The original intention was to feed the 80-mesh screen oversize to the table, but flow of this product was too irregular for successful table operation, so the oversize was returned to the ball mill. Screen undersize contained a fair amount of material that was plus 80-mesh and all minus 48-mesh, as measured by standard Tyler sieves. This undersize was pumped to a 6-compartment type C Fahrenwald sizer used as a deslimer rather than as a sizer; overflow from the sizer was stored temporarily in a 14-foot tank, which, in turn, overflowed to a slime thickener and storage tank. The coarse fraction was treated while operating the grinding unit.

Only the cone of the Fahrenwald sizer was used to feed the table. A small amount of hydraulic water added to the cone when operating the grinding circuit removed most of the slime and fines, allowing the coarser particles to be fed to the table with the finer fraction. While tabling the stored overflow material, all of the hydraulic water was turned off, and the sizer was used only as a feeder for the table.

All of the material was tabled on a No. 14 Diester-Overstrom diagonal deck table 4 feet 8-3/4 inches wide at the head-motion end by 8 feet 3-3/4 inches long parallel to the head-motion axis; this table has less than half the area of a standard table with dimensions 6 feet 8-1/2 inches by 14 feet 3 inches. The table was pool-riffled for fine sands or slime separation, the ordinary riffles being 1/8-inch high at the head end by 1/4-inch

wide, every eighth riffle was a pool riffle 1/4-inch high. The table speed was 272 strokes per minute, and the length of stroke ranged from 3/8 to 3/4 inch, the shorter stroke being used on the finer feed. Vanning-plaque tests made in connection with tabling operations, particularly on the finer sizes, indicated that whenever the table was overloaded, fine corundum washed into the slimes and tailings.

A large, white, fluorescent light mounted over the table helped to determine the line of separation between the corundum and middling product, but andalusite was mostly obscured in the middling, and the depth of cut had to be determined by specific-gravity tests. These tests can be made quickly and accurately with the LeChatelier specific-gravity bottle.

To remove grinding iron from the concentrates, a narrow high cut was made on the table. This was treated later with an electromagnet to remove the iron. The remaining fraction, with an average specific gravity of 3.7, analyzed 91.5 percent Al_2O_3 and appeared to be principally corundum.

Six and one-half tons of ore was ground and classified in accordance with the first flow sheet, but the entire circuit was not cleaned out at the end of the run, and some of the finer material and the middling were left over, to be included in subsequent work. This portion of the work was a transitional stage devoted mainly to adapting the results of laboratory test work to large-scale equipment. The grinding procedure of the circuit produced excessive fines, showing that the Hawthorne ore is readily subject to overgrinding; this condition was the paramount reason for the change to the second flow sheet.

Chemical analyses and specific gravities of table products made while producing the second concentrate lot (first flow sheet) are shown in table 6.

TABLE 6. - Chemical analyses and specific gravities of table products, first flow sheet

Material	Specific gravity	Analysis, percent			
		Al_2O_3	SiO_2	Fe_2O_3	TiO_2
Concentrate.	3.28	67.8	28.77	0.85	0.71
Middling	2.97	44.8	49.00	.43	.92
Tailing.	2.85	33.0	57.24	.57	.87
Slime.	2.74	33.1	57.36	2.56	.77

Second Flow Sheet

The second flow sheet was similar to the first, except that a screen with a 1/2-inch opening replaced the 1/8-inch screen in the coarse-crushing section; the rolls were omitted, only the Symons cone crusher being used for secondary crushing, and a 48-mesh Ton-Cap screen replaced the 80-mesh screen used for sizing the ball mill classifier overflow. The screen analysis of table 7 was made on a representative sample of this coarser ore.

TABLE 7. - Analysis of ore crushed through a one-half inch screen

Mesh	Weight, percent	Cumulative, percent
-3/4"+1/2. . . .	4.27	4.27
-1/2"+4.	58.30	62.57
-4+6	7.90	70.47
-6+8	5.70	76.17
-8+10.	4.96	81.13
-10+14	3.23	84.36
-14+20	2.89	87.25
-20+28	2.25	89.50
-28+35	1.90	91.40
-35+48	1.48	92.88
-48+65	1.38	94.26
-65+100.	1.28	95.54
-100+200	1.87	97.51
-200	2.49	100.00

Ball mill feed rate on this coarser material was started at a rate of 2,760 pounds per hour and was increased to the maximum continuous capacity of 3,630 pounds per hour while grinding through the 48-mesh Ton-Cap screen. The ball mill discharge pulp was maintained between 50 and 60 percent solids, which was diluted to give a classifier overflow product of between 40 and 45 percent solids. A screen analysis made on a sample of the 48-mesh Ton-Cap screen undersize is shown in table 8.

The coarser crushing and grinding still tended to create an excessive quantity of fines and slimes. For classifying, the cone of the Fahrenwald sizer was eliminated, and the third compartment was used to feed the table. A sample of the coarse table feed from the sizer, taken at the same time as the preceding screen undersize sample, yielded the screen analysis also shown in table 8. A screen analysis of the sizer overflow is given in the last column of table 8.

TABLE 8. - Screen analysis of 48-mesh screen undersize product and Fahrenwald sizer products

Mesh	Weight, percent		
	Screen undersize	Sizer underflow	Sizer overflow
-20+35. . .	0.61	3.41	-
-35+48. . .	7.40	24.06	-
-48+65. . .	7.56	35.74	0.52
-65+100 . .	13.13	23.51	3.57
-100+200. .	21.07	12.34	42.72
-200. . . .	50.23	.94	53.19

Table capacity of the coarser material was 350 to 450 pounds per hour. The small difference in specific gravity of the minerals prevented them from spreading out over the table, causing the entire table feed to follow along the ends of the riffles and to fan out to about 18 inches at the concentrate end. A narrow band of bluish-gray corundum was visible along the upper edge of the fan. The fine table feed formed a much wider corundum band, which was attributed to better liberation and a smaller amount of middling product. The spread of the fan in this case, virtually covered

the entire concentrate end of the table, reducing the table capacity to 200 or 250 pounds of dry feed per hour. Tilting the table more would wash the concentrates over the tailing side. Most of the slime and coarse mica washed off the head end of the table, regardless of the feed size.

Approximately 33 tons of minus 1/2-inch ore was milled in accordance with flow sheet 2, producing concentrates 3 to 9, inclusive. Inasmuch as 50 percent of the ore was ground to minus 200-mesh in this circuit, it was decided to attempt a lighter grind and a coarser table feed with additional classification before tabling.

Third Flow Sheet

The third flow sheet is outlined in figure 4. The 2,100 pounds of 4-inch balls in the mill were removed and replaced with an equal weight of 1-1/2-inch balls in an effort to reduce over-grinding. The 48-mesh screen receiving the ball mill classifier overflow product was replaced by a 20-mesh screen, and the undersize from this passed to another rake classifier 24 inches wide by 15 feet long. Classifier sand product passed to the Fahrenwald sizer, where two pockets were used to produce two underflow sized products instead of one as in the previous flow sheets. The coarsest sizer product flowed directly to the table, the intermediate product was stored temporarily in a 7-foot tank, and the sizer overflow was combined with the classifier overflow to be stored in the 14-foot tank.

The change in the ball load did not noticeably affect operation of the ball mill; the maximum feed rate remained at 3,630 pounds per hour. Screen analyses of the classifier sand discharge and the three table feed products are shown in table 9.

TABLE 9. - Screen analyses of classifier and Fahrenwald sizer table feed products, flow sheet 3

	Weight, percent			
	Classifier 2 sand discharge	Fahrenwald sizer products		Classifier and Fahrenwald overflow products
Mesh		Coarse	Intermediate	
-20+28	6.87	16.74	-	-
-28+35	8.05	17.61	1.60	-
-35+48	12.76	22.61	6.91	-
-48+65	16.88	17.39	14.63	-
-65+100	21.10	11.96	29.26	-
-100+200	21.49	10.87	43.09	16.87
-200	13.05	2.82	4.51	83.13

Approximately 8 tons of ore was treated by the process shown in the third flow sheet and produced concentrates 10 and 11, the former from the coarse and intermediate sizer products and the latter from the classifier and sizer overflows. The middling from this run was stored separately from the middling products made previously and was tabled again later to produce concentrate 14.

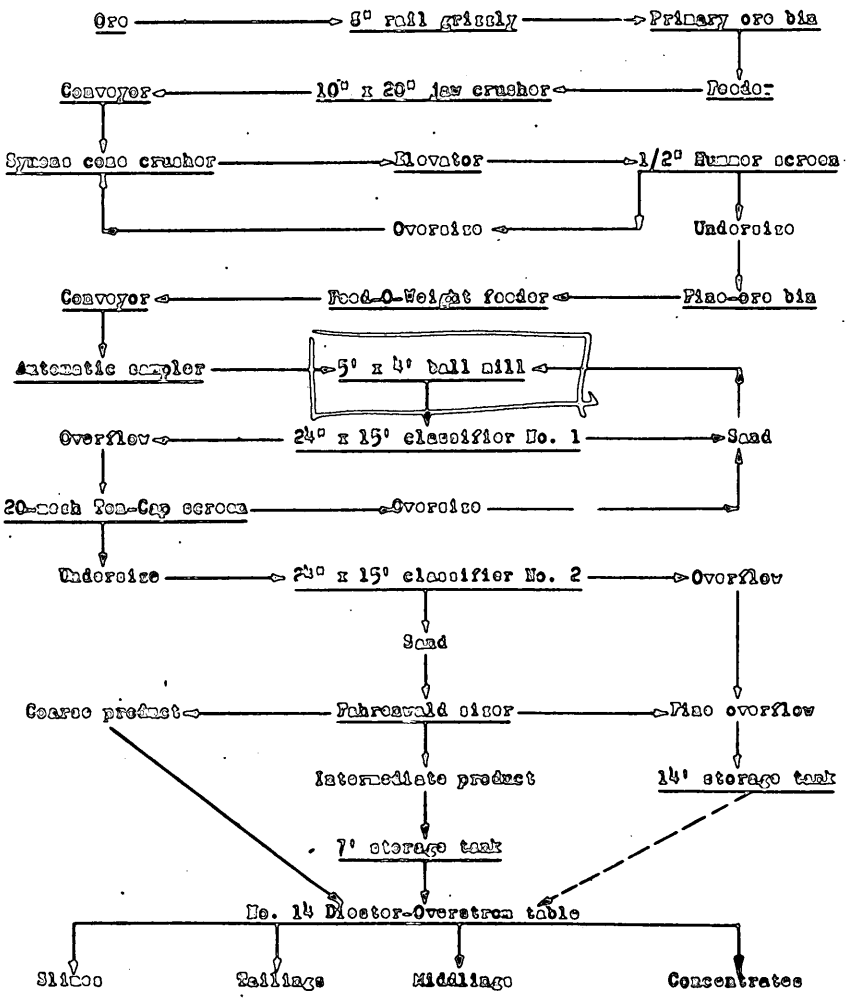


Figure 4. - Third flow sheet

Re-treatment of Middlings

A total of 8.94 tons of various middlings, dry weight, was produced from the 47.5 tons of ore used in the three flow-sheet processes. The middlings contained some free corundum and a fair amount of andalusite, which were recoverable by tabling without regrinding. Partial analyses of the middlings products are given in table 10.

The middlings from the first and second flow-sheet processes were passed over a 100-mesh Hummer screen and separated into a coarse and fine product, each of which was tabled separately to make concentrates 12 and 13, respectively. Middling from the third flow-sheet process was treated separately to produce concentrate 14. The rejected portion of the

middling has been called coarse and fine middling tailing in the summarized data.

TABLE 10. - Analyses of middlings

Number	Percent			
	Al_2O_3	SiO_2	Fe_2O_3	TiO_2
1	44.6	46.5	0.99	0.82
2	44.8	49.0	.43	.92
3	41.3	51.2	.49	.61
4	48.9	45.9	.28	.66
5	51.4	42.1	.28	.77
6	47.7	42.6	.35	.92
7	45.2	46.8	.31	1.17
8	47.9	46.3	.35	.92
9	44.4	49.4	.42	.82
Weighted average	45.3	47.4		

Concentrates and Recovery Data

Weights, particle size, specific gravity, and chemical analyses of all the concentrates are listed in table 11, and the pyrometric cone equivalents for each concentrate are listed in table 12.

The concentrates show a wide range in grade which, excluding the small amount of high-grade corundum recovered as concentrate 16, varied between 52.1 to 72.4 percent Al_2O_3 and 25.2 to 44.9 percent SiO_2. This range of concentrate grade may prove to be valuable, as the main objective of this work was to produce enough high-alumina material so that refractory tests could be made to determine the value of the products.

TABLE 12. - Pyrometric cone equivalents,* andalusite-corundum concentrates

Concentrate	Assay, percent		P. C. E.* No.	Temperature, °C.
	Al_2O_3	SiO_2		
1	62.6	34.5	37+	1,820+
2	60.4	37.6	37+	1,820+
3	60.3	35.9	38-	1,835-
4	67.6	29.3	38	1,835
5	69.2	28.7	39	1,865
6	67.1	28.7	40	1,885
7	66.3	29.5	38+	1,835+
8	72.4	25.2	38	1,835
9	68.0	30.2	40+	1,885+
10	65.4	33.6	38	1,835
11	65.8	32.3	39+	1,865+
12	52.1	44.9	35+	1,785+
13	62.2	35.7	38+	1,835+
14	52.3	44.1	35-	1,835-
15	59.0	39.6	37.5	1,827
16	91.5	5.7	41-	1,970-
Composite	62.3	35.1	38	1,835

*As determined by Northwest Experiment Station, Bureau of Mines, Seattle, Wash.

A large proportion of each concentrate has been shipped to Gladding, McBean & Co. at Pittsburg, Calif., for testing their value as a refractory. Other proportionate parts of the concentrates have been distributed within the Bureau of Mines for refractory and other test work.

TABLE 11. - Andalusite-corundum concentrates

Flow sheet	Concentrate	Weight pounds	Particle size*	Specific gravity	Chemical analyses, percent						
					Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O	MnO_2**
1	1	440	Fine	3.37	62.6	34.5	0.89	0.71	0.27	0.11	0.75
1	2	640	do.	3.28	60.4	37.6	.98	.71	.29	.03	.13
1-2	3	1,587	Coarse	3.20	60.3	35.9	.63	.87	.36	.05	.10
2	4	588	Fine	3.31	67.6	29.3	.42	.77	.25	.02	.05
2	5	550	do.	3.36	69.2	28.7	.56	.87	.34	.02	.05
2	6	555	do.	3.36	67.1	28.7	.56	.77	.31	.07	.03
2	7	1,873	Coarse	3.33	66.3	29.5	.49	.77	.34	.07	.03
2	8	1,171	do.	3.40	72.4	25.2	.78	.82	.25	.06	.04
2	9	3,323	Fine	3.33	68.0	30.2	.42	.77	.17	.07	.10
3	10	752	Coarse	3.27	65.4	33.6	.54	.87	.35	.13	-
3	11	1,923	Fine	3.28	65.8	32.3	.58	.66	.29	.17	.10
Middling	12	5,214	Coarse	3.08	52.1	44.9	.49	.77	.48	.25	.05
Do.	13	3,030	Fine	3.24	62.2	35.7	.42	.66	.26	.17	.12
Do.	14	221	Coarse	3.10	52.3	44.1	1.09	.77	.53	.19	.08
Clean-up	15	558	Fine	3.22	59.0	39.6	.41	.77	.38	.07	.70
Hi-grade	16	182	do.	3.76	91.5	5.7	.70	.77	.08	Tr.	.40
Composite		22,605		3.25	62.3	35.1	.53	.76	.32	0.15	-

*The fine size is approximately minus 65-mesh. The coarse size is approximately minus 20-mesh with some minus 100-mesh.
**MnO_2 is an extraneous impurity resulting from contact of the ore with launders, pipe lines, and other equipment that had previously been used for manganese milling tests.

Andalusite is marketed on a specification of 60 to 65 percent Al_2O_3 content and a specific gravity of 3.05 to 3.15. Many buyers also specify that 25 to 50 percent of the product should be minus 4- and plus 10-mesh. This latter specification was not met by any of the test products. Furthermore, it does not appear possible that such a specification can be met on the type of ore received, because of the intimate mineralogical association as shown by microscopic examination and in photomicrographs (figs. 1 and 2).

A weighted composite of all the concentrates produced analyzes 62.03 percent Al_2O_3, which would place this material in a class equivalent to a marketable grade of andalusite, provided that mineralogical character and refractoriness prove satisfactory. Material between 50 and 70 percent Al_2O_3 can be composited from the various lots for the refractory tests.

The distribution by weight, the chemical analyses, and specific gravities of the heads, tailings, and concentrates, are given in table 13.

Table 13. - Distribution and analyses of mill test products

Material	Weight, pounds	Chemical analyses, percent						Sp. g.	P.C.E.*
		Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O		
Concentrate	22,603	62.3	35.1	0.53	0.76	0.32	0.15	3.25	38
Coarse middling tailing.	6,718	37.3	61.4	.19	.87	.66	.17	2.92	31.5
Fine middling tailing	2,706	35.4	62.9	.14	.87	.52	.16	2.90	31+
Tailing.	18,454	36.4	60.8	.19	.77	.61	.19	2.89	32.5-
Slime.	44,600	35.6	61.4	.32	.92	1.14	.17	2.87	31-
Calculated heading. .	95,083	42.2	55.1	.42	.85	.79	.17	2.97	-
Heading by analysis .	-	42.5	54.2	.43	.77	.73	.29	2.95	32

*Pyrometric cone equivalent.

From the table, the ratio of concentration was 4.2 to 1. A lower-grade product containing between 50 and 55 percent Al_2O_3 may prove to be suitable for certain refractory purposes. A product made by combining the concentrates and the middlings as produced in this test operation would contain about 52.5 percent Al_2O_3; such a product would total 32,030 pounds, representing a ratio of concentration of 3.0 to 1.

CONCLUSIONS

1. Over 11 tons of table concentrates, in lots containing 50 to 70 percent Al_2O_3, were made from Hawthorne, Nev., ore. These are to be used for ceramic and refractory tests to determine their value in compounding high-alumina refractories.

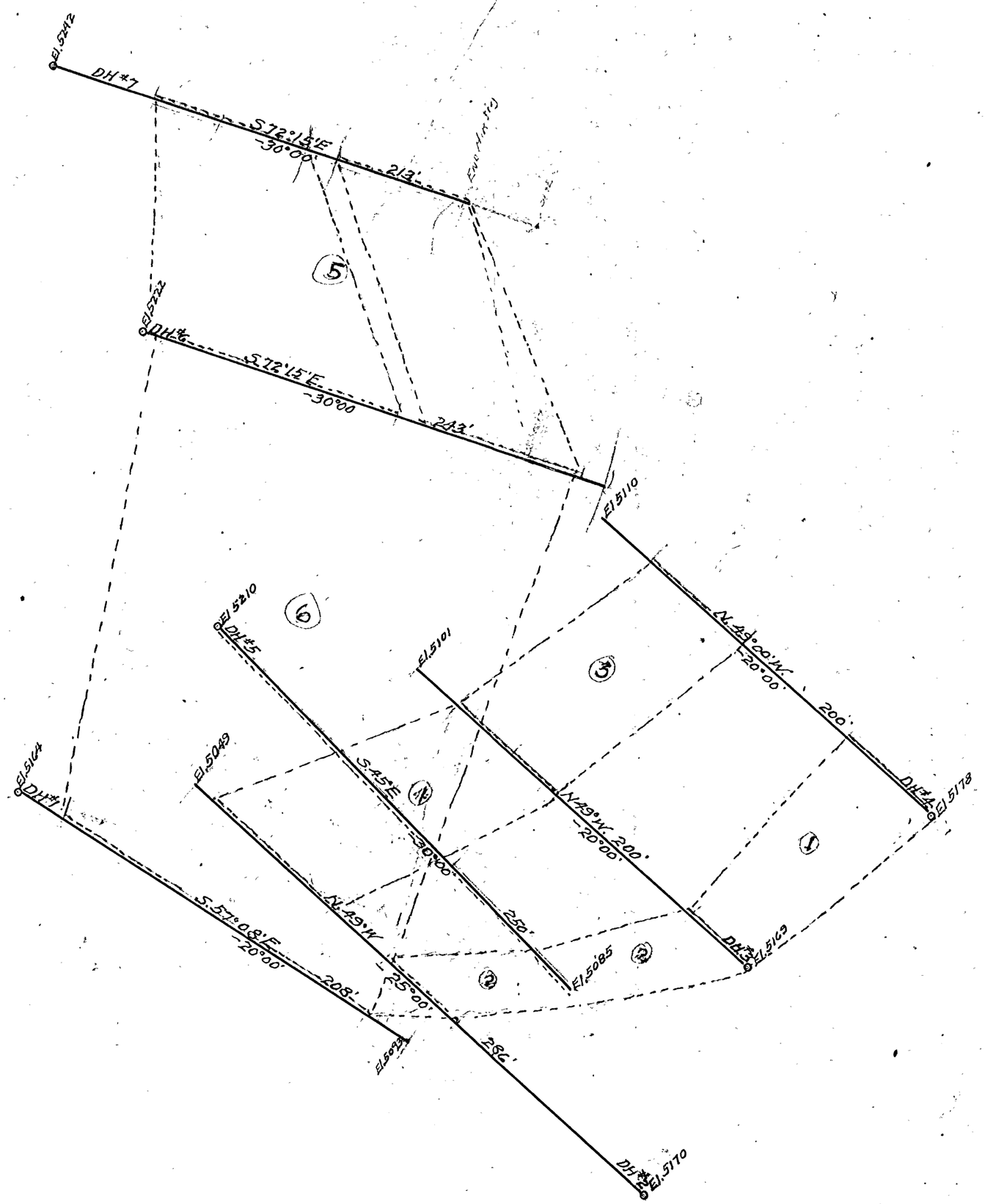
2. If a certain standard quality of the concentrates analyzing between 50 and 65 percent Al_2O_3 proves to be of commercial value, such a product can be produced by table concentration. A commercial plant designed to provide well-classified and steady feed rates to tables undoubtedly could produce a fairly uniform product or a series of products varying in grade.

3. Specific-gravity determinations can be made quickly; they are reliable evidence of the product grade and may be used as a method of control in tabling operations.

4. The large proportion of minus 200-mesh fines produced by grinding suggests the possibility that additional recovery might be made by flotation on this material, provided such a product would have value. The formation of excessive amounts of fines in grinding is apparently an inherent characteristic of the ore, which is a mixture of hard and soft minerals, most of them extremely fine-grained.

5. Economic evaluation of a process for producing concentrates from Hawthorne ore by table concentration will depend upon the outcome of ceramic and refractory tests. Before such an appraisal can be made, the value and grade of a standard concentrate, as well as the use-value of any substandard byproduct, must be determined.

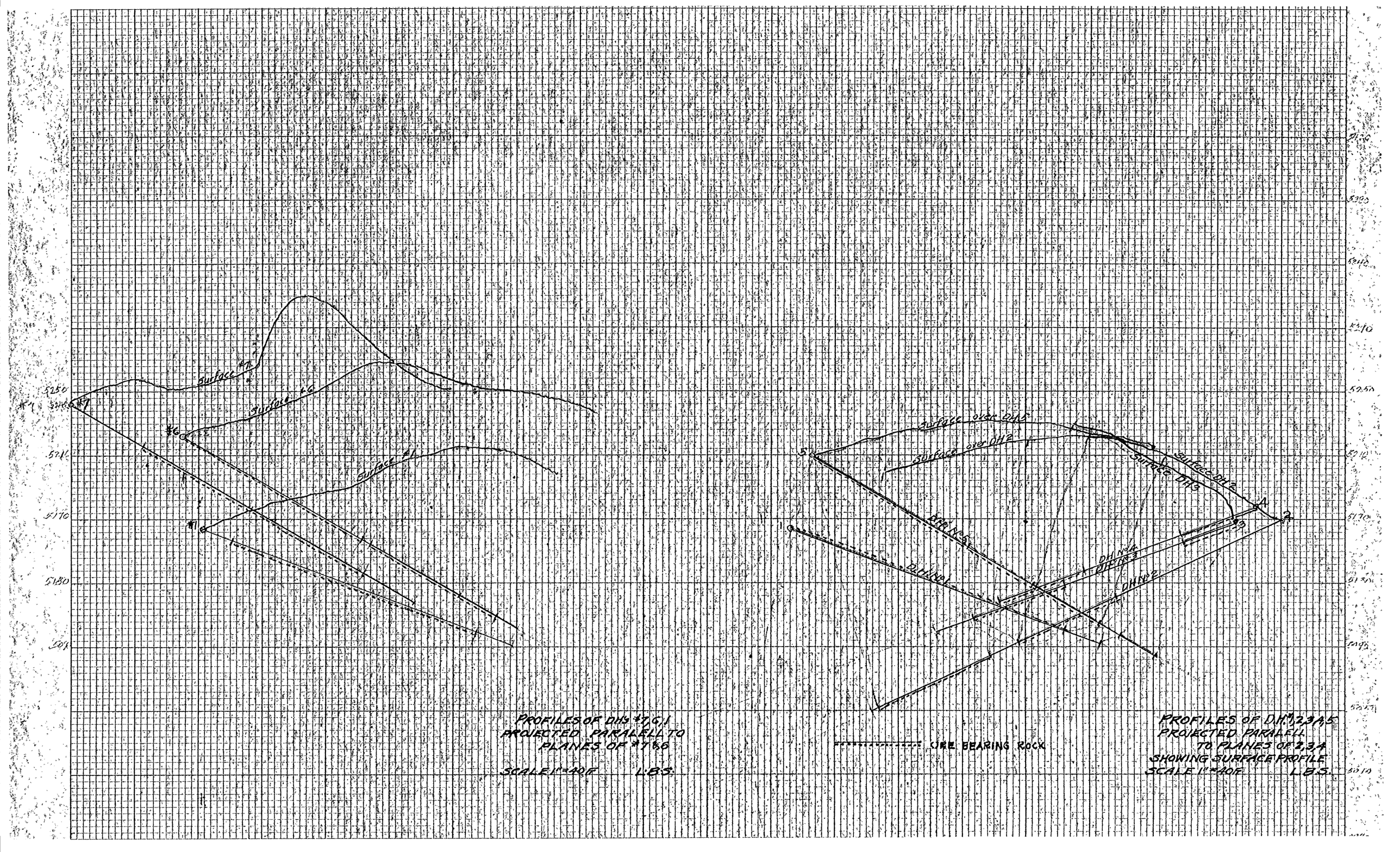
oOo

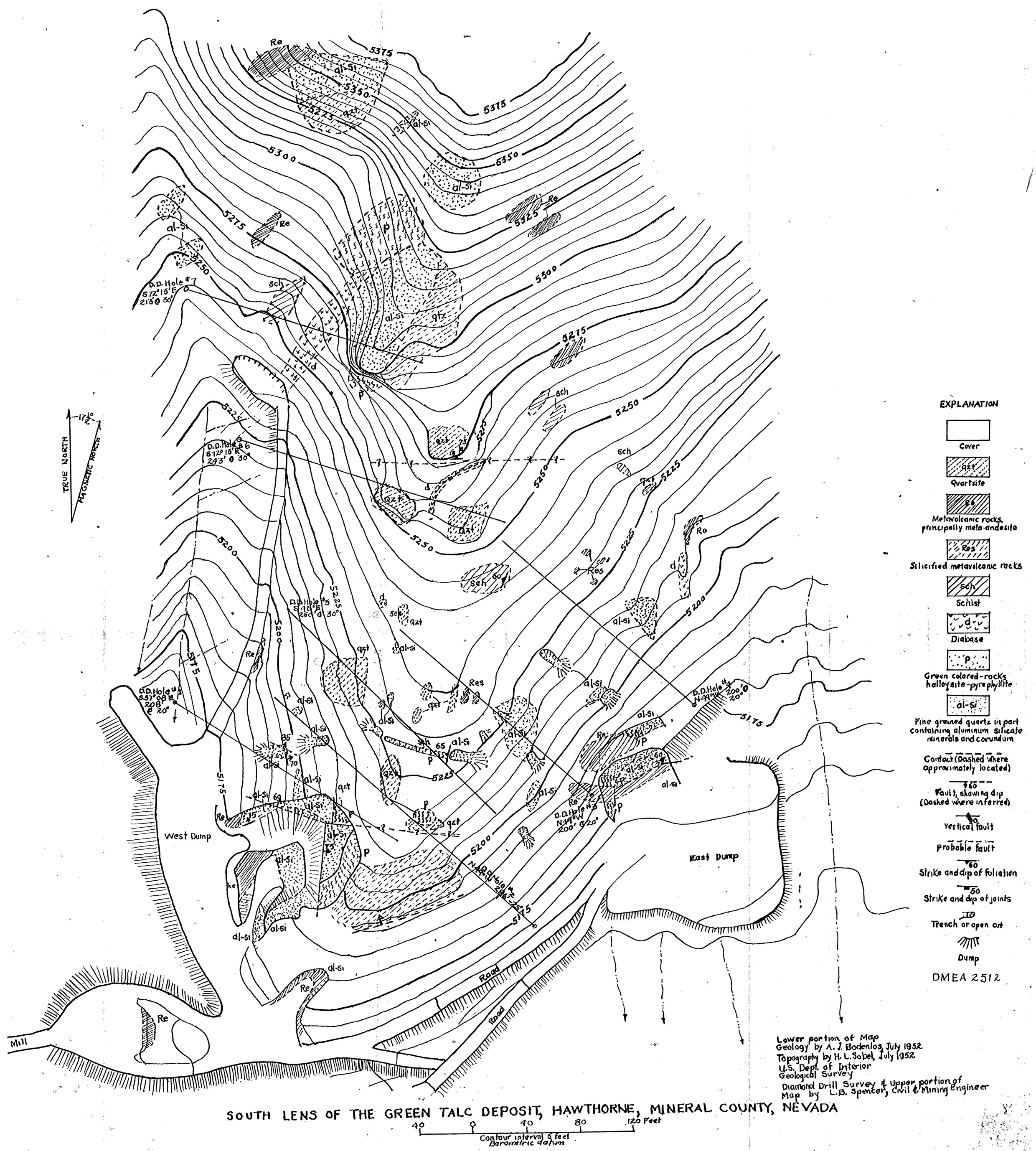


PLAN VIEW OF D.D. HOLES
& ORE BLOCKS, GREEN TALC MINE
CORANDA CORPORATION BY L.B.S.
SCALE 1" = 40'

======= ORE BEARING AREA

------- OUTLINE OF MINERALIZED AREA

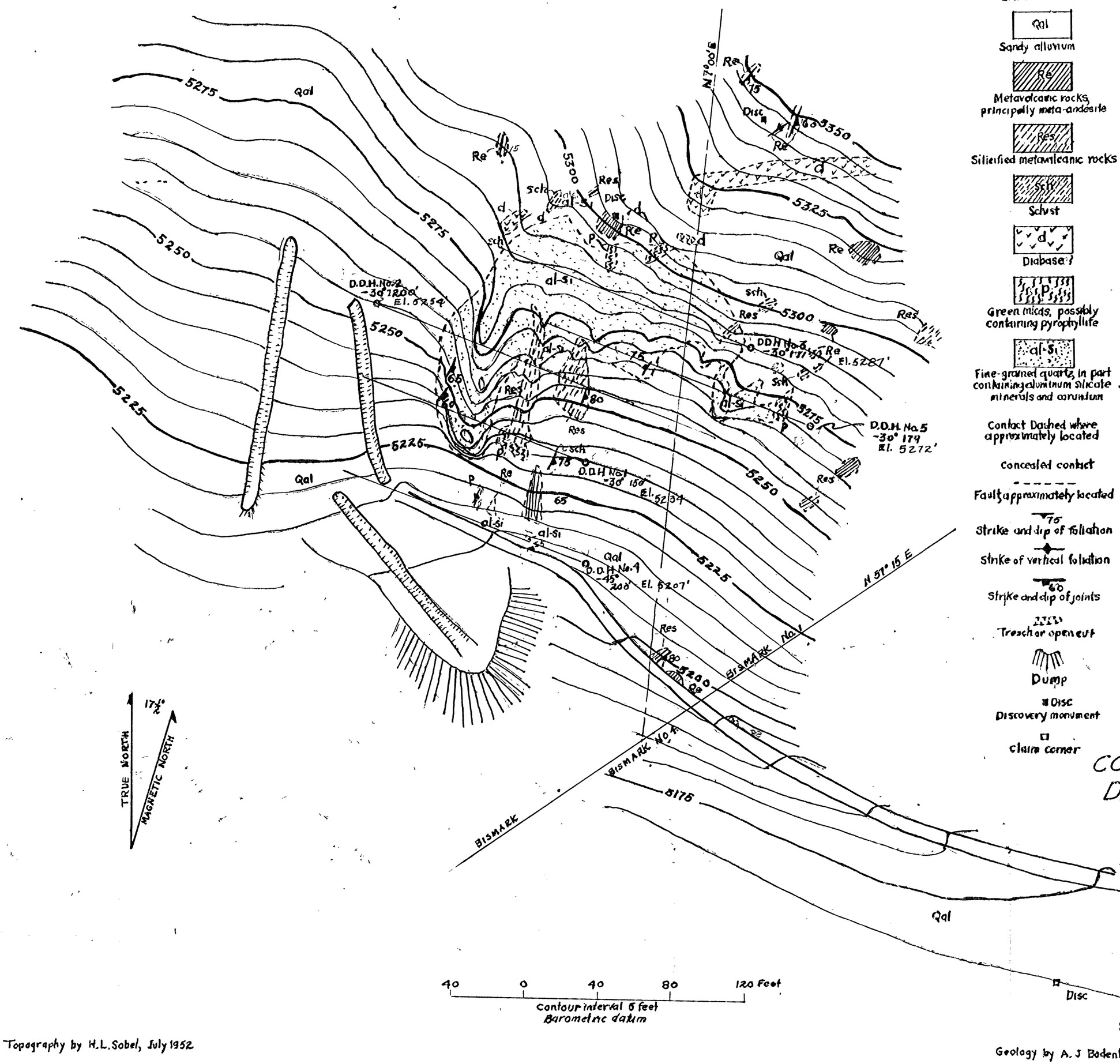

5250
5210
5170
5130
5090
5250
5210
5170
5130
5090
5250
5210
5170
5130
5090
Surface #7
Surface #6
Surface #1
#7
#6
#1
Surface DH5
Surface DH2
Surface DH3
Surface DH2
5
1
A
2
B
Ore Body
DH No 1
DH No 4
DH No 3
DH No 2
PROFILES OF DHs #7,6,1
PROJECTED PARALELL TO
PLANES OF #7&6
SCALE 1"=40F
L.B.S.
ORE BEARING ROCK
PROFILES OF D.H.#1,2,3,4,5
PROJECTED PARALELL
TO PLANES OF 2,3,4
SHOWING SURFACE PROFILE
SCALE 1"=40F
L.B.S.



SOUTH LENS OF THE GREEN TALC DEPOSIT, HAWTHORNE, MINERAL COUNTY, NEVADA

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

DMEA-2512



EXPLANATION

Qal — Sandy alluvium

Re — Metavolcanic rocks, principally meta-andesite

Res — Silicified metavolcanic rocks

Sch — Schist

d — Diabase?

P — Green micas, possibly containing pyrophyllite

al-Si — Fine-grained quartz, in part containing aluminum silicate minerals and corundum

Contact Dashed where approximately located

Concealed contact

Fault approximately located

75 — Strike and dip of foliation

Strike of vertical foliation

60 — Strike and dip of joints

Trench or open cut

Dump

Disc — Discovery monument

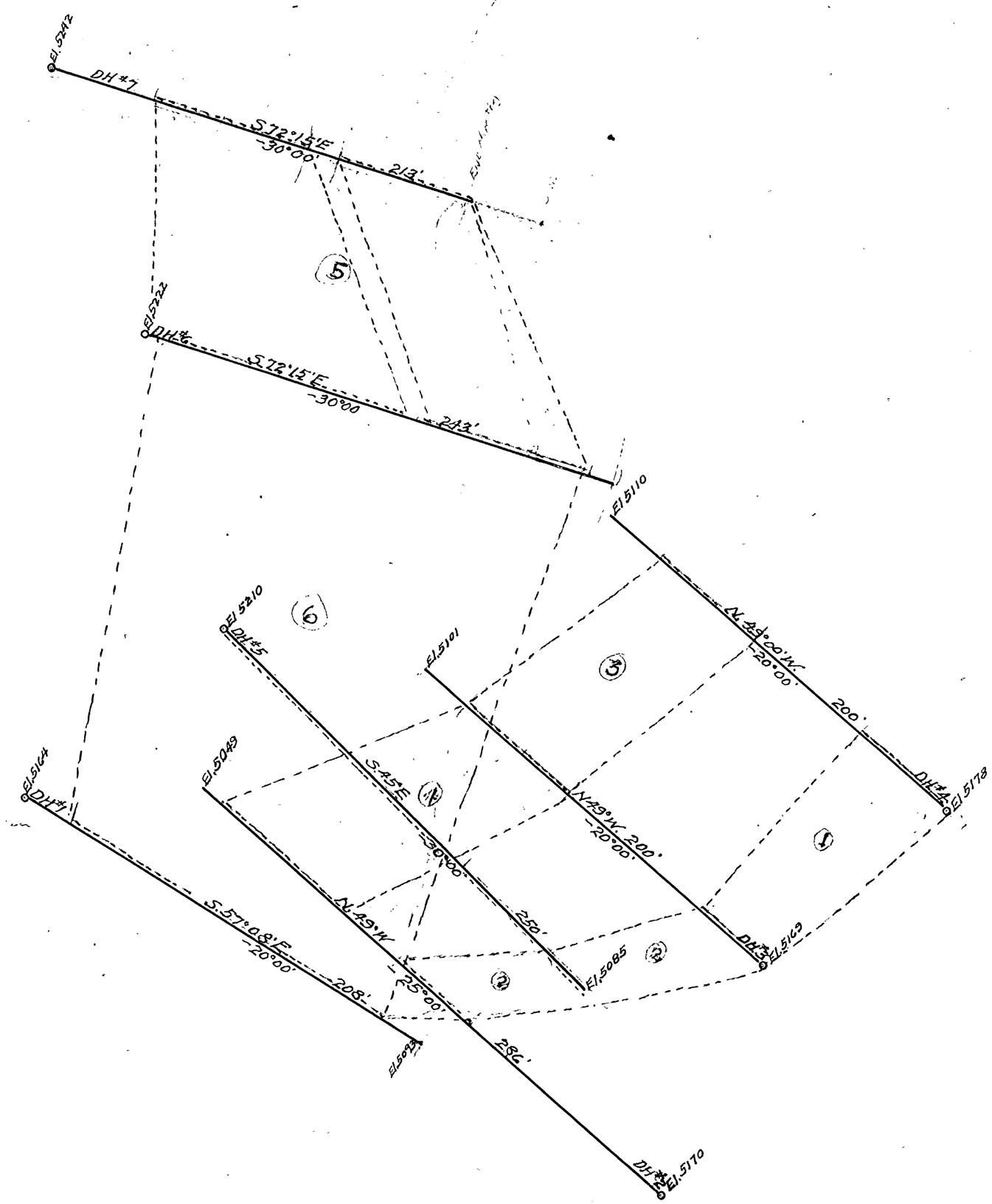
claim corner

CORANDA CORPORATION
DRILL HOLES #1,2,3,4 & 5
ON
BISMARK MINE
AS SURVEYED BY L.B. SPENCER
SCALE 1" = 40 ft.

Topography by H.L. Sobel, July 1952

Geology by A.J. Bodenlos, July 1952

BISMARK ANDALUSITE DEPOSIT, HAWTHORNE, MINERAL COUNTY, NEVADA



PLAN VIEW OF D.D. HOLES
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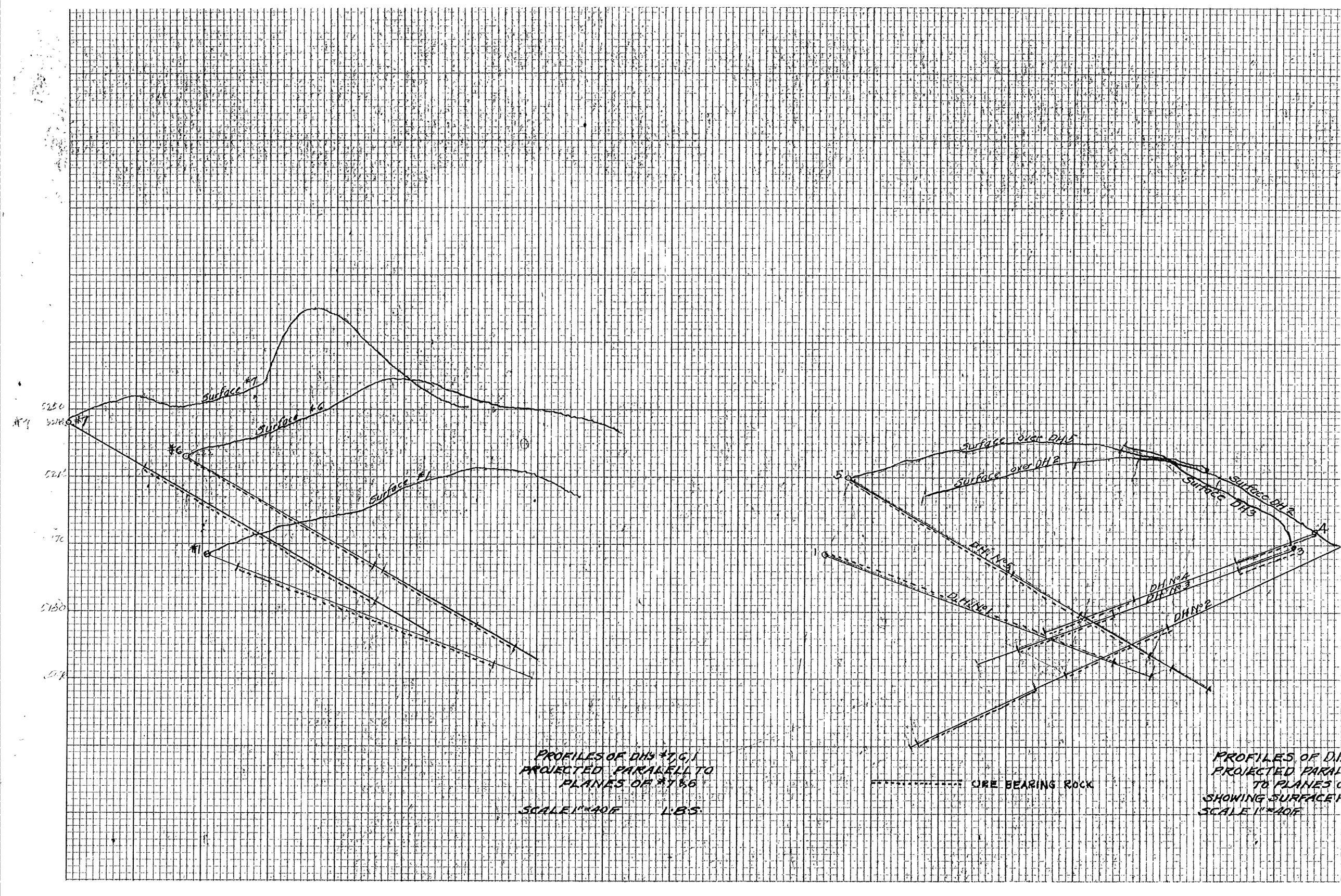
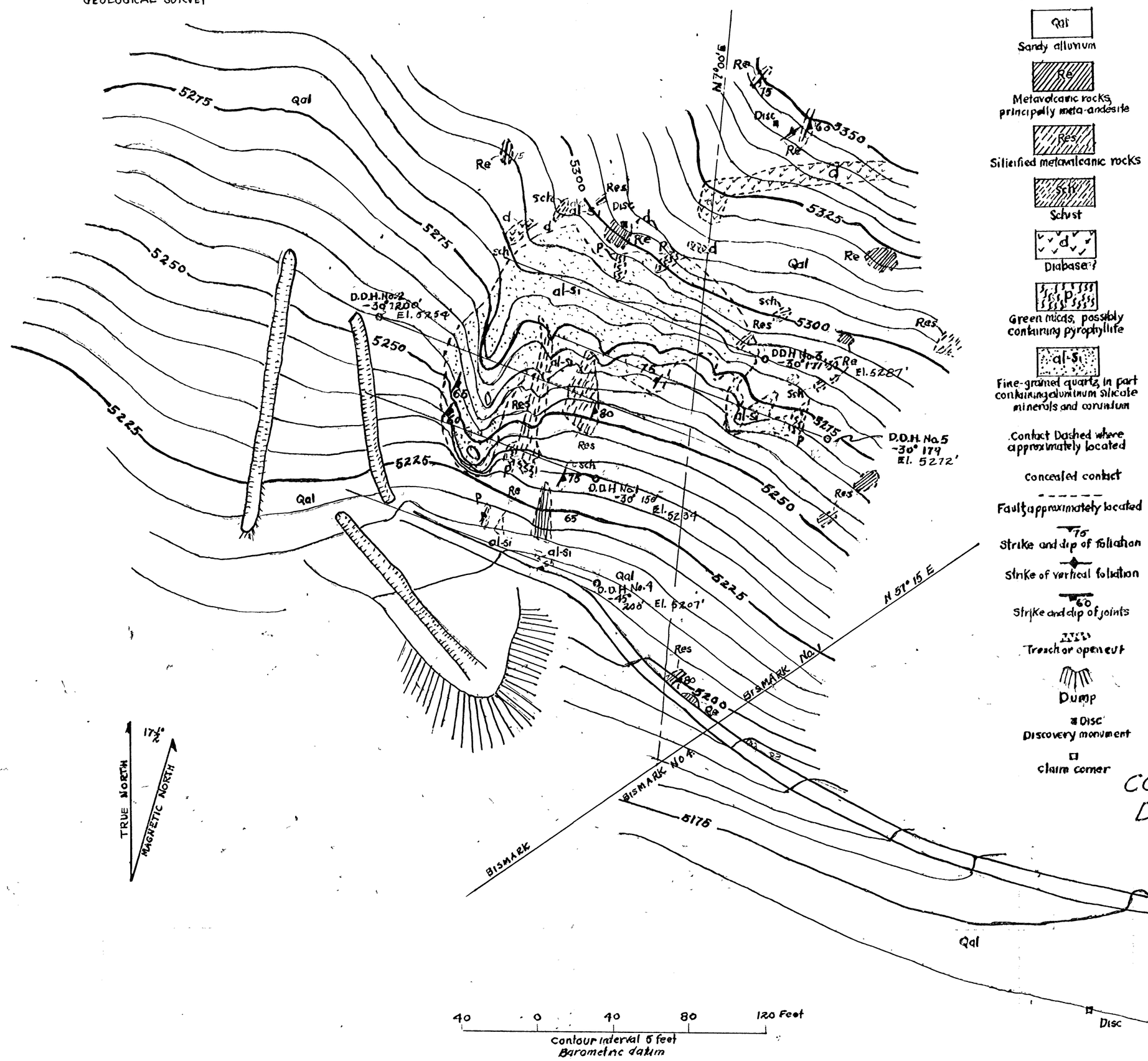
CORANDA CORPORATION BY L.B.S.
SCALE 1" = 40'

======== ORE BEARING AREA
- - - - - - - OUTLINE OF MINERALIZED A


Surface #7
Surface #6
Surface #1
#7
#6
#1
5250
5230
5180
5130
Surface over DH5
Surface over DH2
Surface DH3
Surface DH2
5
1
A
3
DH No 5
DH No 1
DH No A
DH No 3
DH No 2
PROFILES OF DHs #7,6,1
PROJECTED PARALELL TO
PLANES OF #7&6
SCALE 1"=40F
L.B.S.
ORE BEARING ROCK
PROFILES OF DH
PROJECTED PARAL
TO PLANES
SHOWING SURFACE
SCALE 1"=40F

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



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Fault approximately located

75 — Strike and dip of foliation

Strike of vertical foliation

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claim corner

CORANDA CORPORATION
DRILL HOLES #1,2,3,4&5
ON
BISMARK MINE
AS SURVEYED BY L.B. SPENCER
SCALE 1" = 40 FT.

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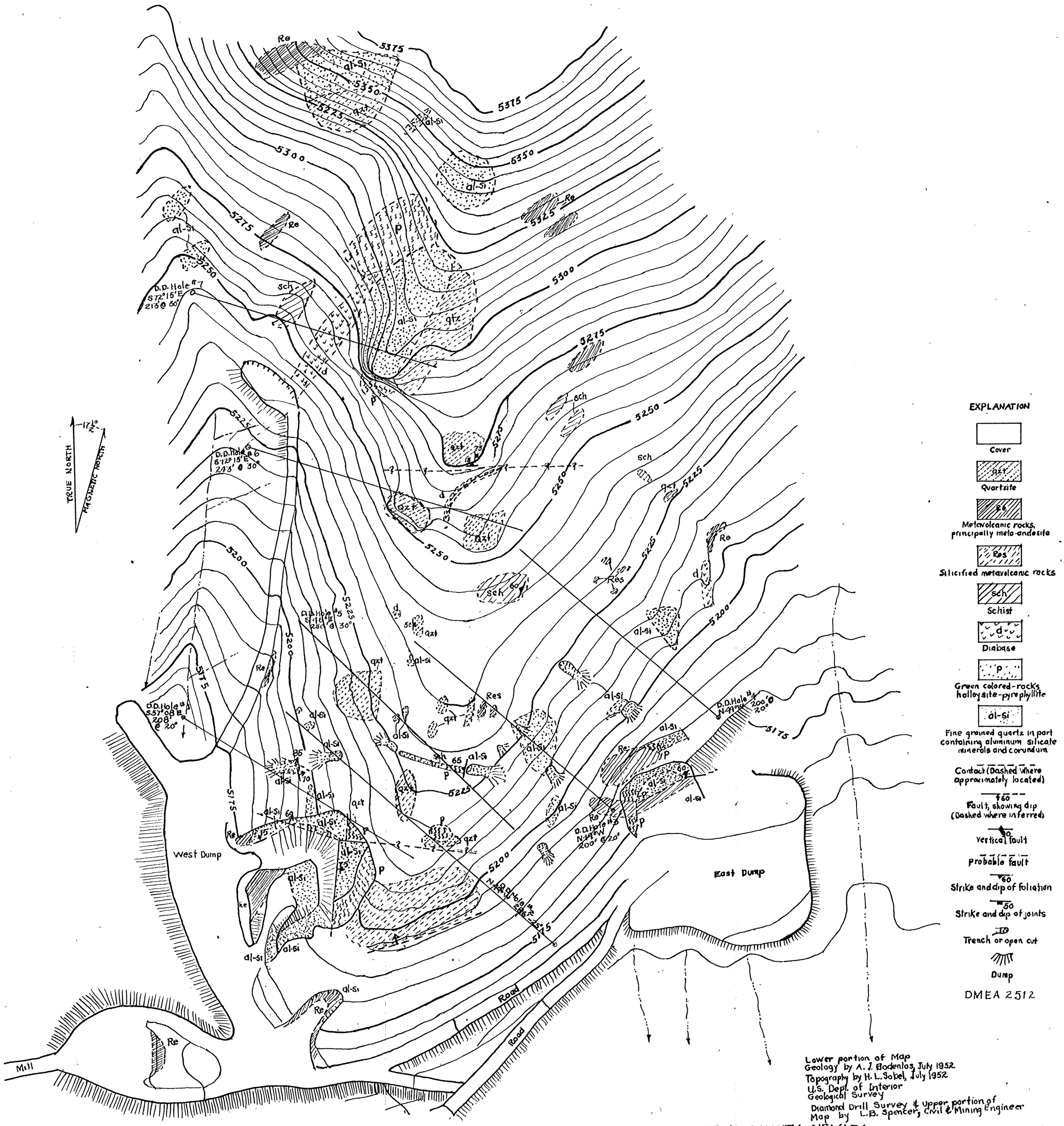
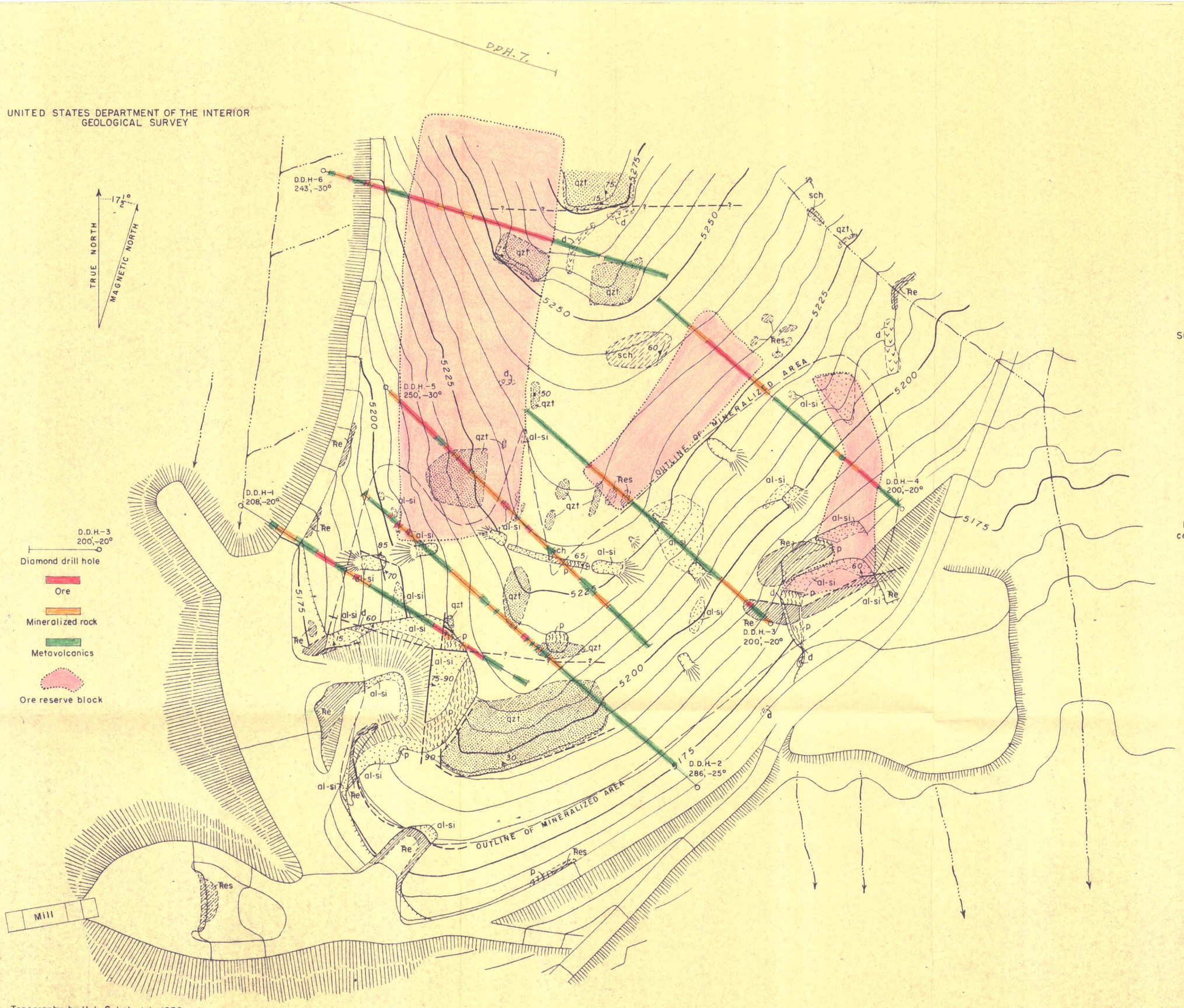
BISMARK ANDALUSITE DEPOSIT, HAWTHORNE, MINERAL COUNTY, NEVADA



SOUTH LENS OF THE GREEN TALC DEPOSIT, HAWTHORNE, MINERAL COUNTY, NEVADA

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

DMEA-2512



EXPLANATION

- Cover
- qzt — Quartzite
- Re — Metavolcanic rocks, principally meta-andesite
- Res — Silicified metavolcanic rocks
- sch — Schist
- d — Diabase(?)
- p — Green micas, possibly containing pyrophyllite
- al-si — Fine-grained quartz, in part containing aluminum silicate minerals and corundum
- Contact (Dashed where approximately located)
- 60 — Fault, showing dip (Dashed where inferred)
- 90 — Vertical fault
- ? — Probable fault
- 60 — Strike and dip of foliation
- 50 — Strike and dip of joints
- Trench or open cut
- Dump

Topography by H. L. Sobel, July 1952

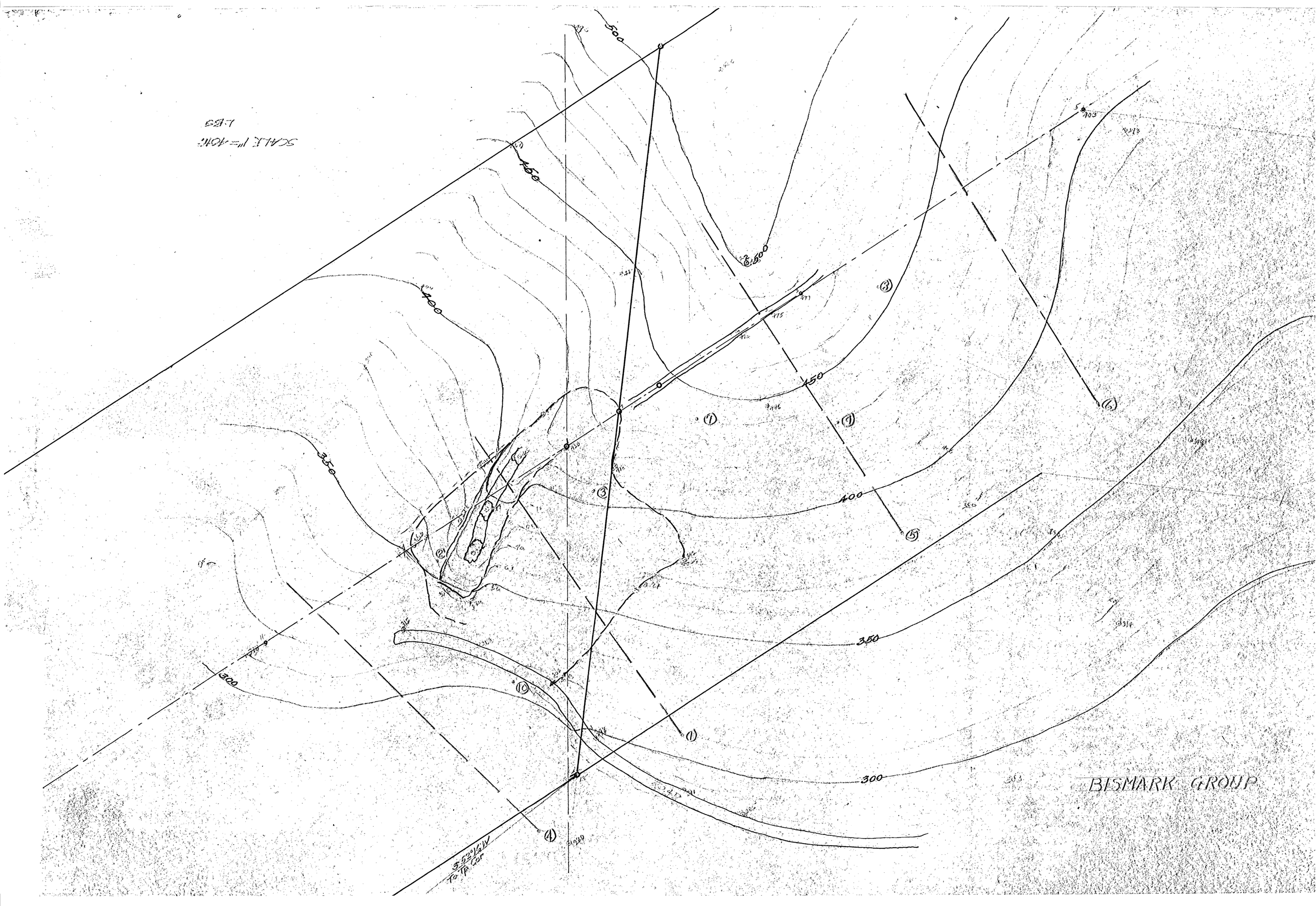
Geology by A. J. Bodenlos, July 1952

Figure 3

SOUTH LENS OF THE GREEN TALC DEPOSIT, HAWTHORNE, MINERAL COUNTY, NEVADA

40 0 40 80 120 Feet

Contour interval 5 feet
Barometric datum


SCALE 1"=40ft.
L.B.S.
BISMARK GROUP
500
450
400
350
300
150
400
350
300
S 52°14' W
To Pt. Cor