DMEA Form 9
Rev. 6/57

UNITED STATES
DEPARTMENT OF THE INTERIOR
Defense Minerals Exploration Administration

OFFICIAL DOCKET FILE — Idm-E NO. 523 — DMEA NO. 2841

Application
- [ ] Denied
- [ ] Withdrawn

Contract
- [ ] Terminated - Not Certified
- [x] Terminated - Certified
- [ ] Cancelled
- [ ] Royalty Agreement

The records contained in this file are marked (x) and arranged in this order:

Folder No. 1:

Left Side

- [x] Royalty Audits
- [x] Certification of Discovery
- [x] Closing Letter
- [x] Cost Audits
- [ ] Termination Notice or Agreement
- [ ] Recision Notice
- [ ] Assignment of Contract
- [x] Contract Amendments
- [x] Contract with all exhibits and annexes
- [x] Owner's Consent to Lien and Subordination Agreement
- [x] Application and attachments

Right Side

- [x] Project summary (final)
- [x] Work Completed analysis (final)

All other material filed in chronological order including the following reports if checked:

- [ ] Field Team Semi-Annual Report for Certified Project
- [x] Final Field Team Report (Tab)
- [x] Operator's Final Report (Tab)
- [x] Interim Field Team Reports
- [ ] Operator's monthly reports and all attachments
- [ ] On-site Exam Report (Tab)
- [ ] Settlement Sheets
- [ ] Drill Logs

Additional Folders:

Left Side

Folders No. _____ : Reports

- [x] Analysis of Semi-Annual Inspection Reports
- [ ] Project Summary (Interim) by DMEA Engineers

Right Side

- [x] Field Team Semi-Annual Report for Certified Project
- [ ] Field Team Interim Reports
- [x] Operator's Monthly Reports with transmittal, narrative and maps.

DRILL LOGS INCLUDED

Folders No. _____ : Maps (Use pocket folder or envelope)

Folders No. _____ : Settlement Sheets

Folders No. _____ : Drill Logs

Folders No. _____ : Royalty material

17963

225

DMEA-2841

OFFICE OF MINERALS EXPLORATION
CONTRACT ADMINISTRATION AND AUDIT DIVISION

REPORT OF ROYALTY REVIEW

I have reviewed the files of the Office of Minerals Exploration, Washington, D. C., pertaining to Contract No. Idm-E523, Docket No. DMEA-2841 (Columbium-tantalum and tin), dated May 18, 1953, with

Foote Mineral Company
18 W. Chelten Avenue
Philadelphia, Pennsylvania

for the purpose of determining the amount of royalty due the U. S. Government on sales of minerals from property referred to as Williams Tracts 3 and 4 located in Cleveland County, North Carolina, during the period May 18, 1953, through June 30, 1960.

A certification of discovery or development was issued on November 19, 1954, and, in accordance with Annex I attached to Amendment No. 3 of the contract, royalty is payable on all minerals mined or produced from the land described in Article 2 of the contract for a period of 10 years from the date of the contract or until the total net amount contributed by the Government without interest is fully repaid, whichever occurs first. An Audit Certificate dated July 20, 1958, indicated accepted costs under the exploration contract amounting to $23,735.10 with the Government's contribution, on a 90 percent basis, being $21,361.59.

This review was made in lieu of an on-site audit of the Operator's accounts and records for the following reasons:

(1) Inspection reports by field representatives of the Government and other correspondence in the Washington office files indicate that there has not been any production of minerals from the property since the date of the exploration contract;

(2) The operator has surrendered the leasehold and has abandoned all interest in the land; therefore, under the "abandonment" clause in Article 10 of the contract, the Government has no lien for royalty on production unless the operator should regain an interest in the land during the 10 year period provided in Article 2; and

(3) The administrative cost to the Government of an on-site royalty audit at this time would be excessive in relation to the amount of possible royalty which might be disclosed.

C. E. Fisher

C. E. Fisher, OME Auditor

July 6, 1960

Docket copy

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Ellis

CERTIFICATION BY THE UNITED STATES OF AMERICA
OF A DISCOVERY OR DEVELOPMENT UNDER
AN EXPLORATION PROJECT CONTRACT

To: Foote Mineral Company
18 W. Chelten Avenue
Philadelphia, Pennsylvania

Pursuant to the provisions of Exploration Project Contract No. Idm-E523, dated May 18, 1953, (Docket No. DMEA-2641), hereinafter called the "contract" between you and the United States of America, hereinafter called the "Government"; to establish and fix the Government's percentage royalty on production and its lien thereon and on the land described in the contract, the Government considers and therefore certifies that discovery or development from which production may be made has resulted from the exploration work.

The nature of said discovery or development is described broadly or indicated as follows:

Trenching and diamond drilling on the land described in Article 2 of the contract proved the existence of five pegmatite bodies containing significant reserves of columbium-tantalum, beryl, tin, and spodumene. The work also indicated potential ore reserves in five other pegmatite bodies.

Dated: NOV 1 9 1954

THE UNITED STATES OF AMERICA

By C. Mittendorf
Administrator, Defense Minerals
Exploration Administration

Approved
Chandler
Selfridge
Johnson

MChing/gla
11-8-54 Operator (original)
cc to: Admr. Reading File
Operating Committee
Mr. J. H. Hedges, Rm. 4604
Mr. T. H. Kiilsgaard, Rm. 5224
Contract Adm. and Audit Div.
Field Team, Region VII (2)
Finance Office
Rare & Misc. Metals Division
Docket
Mr. Irving Gumbel, Acting Dir.,
Materials Division, EPS
Mr. F. E. Johnson
Mr. Ching

MME Form 7
(10-58)

OFFICIAL FILE COPY

Date	Surname	Code
6/21	Murphy	500
6/21	Oxley	500
6/21	Talbert	800
6/21	Leard	120
6/2	Johnson	110
"	Fumich	100
		220

JUN 21 1963

Foote Mineral Company
18 West Chelten Avenue
Philadelphia 44, Pennsylvania

Re: IREA-2841 (Columbium-Tantalum, Beryl, Tin)
Foote Mineral Company
Williams Tracts 3 and 4
Cleveland County, North Carolina
Contract Ldm-8523

Gentlemen:

Thank you for returning the completed MME Form 63's mailed to you on June 12, 1963.

By the terms of the subject Exploration Project Contract, as amended, and the certification of discovery or development dated November 19, 1954, all minerals mined or produced from May 18, 1953 to May 18, 1963, were subject to the Government's royalty as set forth in said contract.

As the period during which production was subject to royalty has now expired, the Government according to its present records retains no claim or lien against the property subject to the contract or any future production therefrom. We, therefore, are closing our books and records on this contract. Your attention, however, is called to the provisions of the contract which require the Operator to keep and preserve certain records for the periods indicated.

Sincerely yours,

George Fumich, Jr.

(pt)

Director

FMMurphy/mm
6/21/63
cc: Mr. & Mrs. L. M. Williams, Blowing Rock, N.C.
Mr. and Mrs. Rube Hatcher, Charlotte, N.C.
Mr. and Mrs. Robert A. Hovis, Charlotte, N.C.
Mr. and Mrs. B. B. Culp, Gastonia, N.C.
Director's ReadingFile
Region IV (2) w/cy of Form 63 dated 6/12/63
CA&A Division
Docket
Code 500

43683

DEFENSE MINERALS EXPLORATION ADMINISTRATION
CONTRACT ADMINISTRATION AND AUDIT DIVISION

AUDIT CERTIFICATE

I have examined the records and transactions of:

Foote Mineral Company
18 West Chelten Avenue
Philadelphia 44, Pennsylvania

pertaining to Exploration Project Contract No. Idm-K523, Docket No. DMEA-2841, including Amendments Nos. 1, 2, 3, 4, 5 and 6, covering a project of exploration for Columbium, Tantalum, Beryl and Tin on the L. M. Williams lease approximately three miles southwest of Kings Mountain, in Cleveland County, North Carolina, for the period July 28, 1953 to July 14, 1954.

My examination was made in accordance with generally accepted standards applicable to the circumstances.

The audit disclosed the following facts in regard to the amount to be paid the contractor:

Total cost as billed by Contractor		$23,782.62
Exceptions (see Audit Report for details):		
Prior to this audit	$ -0-	
During this audit	47.52	47.52
Total Accepted Cost		$23,735.10

The contract calls for a 90 percent participation of exploration expenses by the United States Government. Therefore, payment to the contractor by the Government in the amount of Twenty-one thousand three hundred sixty-one and 59/100 dollars,

$21,361.59

is valid and proper.

This certificate is issued on the provision that the Regional Executive Officer, the Administrator, or other competent official has accepted or will accept the project as having otherwise met the terms of the contract.

W. J. BRUKHUS
Auditor

July 20, 1954

Audit Cert. 7/20/54
Recd. 8/4/54

AUDIT REPORT

I INTRODUCTION

On June 8 and July 14, 1954, a final audit (covering the period July 28, 1953 to July 14, 1954) was made of the records and accounts of operations pertaining to Contract No. Idm-5323, Docket No. DMEA-8541 (as amended by Amendments 1, 2, 3, 4, 5 and 6), with the:

Foote Mineral Company
18 West Chelten Avenue
Philadelphia 44, Pennsylvania

covering a project of exploration for Columbium, Tantalum, Beryl and Tin in the pegmatite dikes of Tracts 3 and 4 on the L. M. Williams lease about three miles southeast of Kings Mountain, North Carolina.

The accounting records under this contract are located in the Company's office at the site of the mill about two miles south of Kings Mountain, North Carolina. Mr. D. R. Smith the plant accountant made the books and source documents available for audit, and made explanations as required. Mr. Thomas L. Kesler, chief geologist, was also present for consultation relative to physical accomplishment and technical phases of the operations. Their cooperation and assistance greatly facilitated the audit. Mr. Wm. A. Beck, Mining Engineer, Region VII, collaborated in the audit.

II GENERAL INFORMATION ON RECORDS

The accounting records for the exploration project are completely integrated, through an apparently modern and comprehensive system, with the general branch accounts covering the Company's exploration, development quarrying, mill and other operations. A separate cost account covering DMEA exploration is maintained, which reflects all project costs to the Company. Billings have been made to the Government covering actual costs incurred without regard to whether they were within the terms of the contract. The amounts disallowed were minor and are covered in detail under appropriate subsections of this report.

Monthly work sheets covering billings under the exploration contract were not maintained. This resulted in developing minor discrepancies when analysis was made of the items of cost for (3) Operating Materials and Supplies. The audit involved an analysis of all costs as shown and a general check of source documents against the monthly billings.

III SCOPE OF AUDIT AND FINDINGS

The audit was limited to ascertaining the accuracy, propriety and validity of the costs as shown in the "Totals to date" column on Form MF-104, Operator's Monthly Report and Voucher, for the month of July, 1954. The extent of the audit and findings under each of the "Items of Cost" follow:

(1) Agreed Estimated Unit Costs $14,094.38

Diamond core drilling was performed by the Operator at an agreed unit price. The contract as originally drawn stipulated an NX hole yielding cores not less than 2-1/8 inch diameter, at a price of $7.80 per foot. Amendment No. 3 dated October 30, 1953, modified this requirement and provided for the drilling of NX holes yielding cores 1-5/8 inches in diameter at a price of $7.00 per foot, the smaller size to be used whenever the larger size is not practical for efficient operation.

Non-coring roller bit drilling as covered by Amendment No. 4 was performed at an agreed unit price of $2.35 per foot. Channeling provided for in the contract was performed at an agreed unit price of $.90 per foot. The contract provided for not in excess of 2,140 feet of 6x6 channels. However, after completing 422 feet, channeling was discontinued by mutual agreement between the representatives of the Operator and DMEA Field Team.

Performance of work called for under this subsection was verified by inspection of Operator's monthly progress reports, and DMEA field representatives periodic inspection reports. The drill logs were checked in detail and found to agree with the above mentioned reports, and billings on the MF-104's. The charges in this category, all allowable under the terms of the contract, consisted of the following:

Diamond Drilling NX Core	902'	@	$7.80	$ 7,035.60
" " NX Core	831.1'	@	7.00	5,817.70
Non-Core Drilling	366.5'	@	2.35	861.28
Channeling	422'	@	.90	379.80
Total				$14,094.38

(1) Independent Contract $100.00

The contract provided for bulldozing to be performed by independent contract, a maximum of five days at $100.00 per day for a D-8 bulldozer. The work was performed by requisitioning a TD-18 International Caterpillar with driver from the mill division of the Company for one day at a charge of $100.00 therefor. The work performed and the amount charged has been accepted by the representatives of the DMEA Field Team as being fair and reasonable. As the contract contemplated this work was to be performed by an independent subcontract, the Operator at time of audit

presented proof of reasonableness of rate charged as evidenced by billings for other bulldozer rentals paid at that time. In view of the foregoing the amount is considered acceptable as costs within the terms of this contract.

(2) Labor and Supervision $4,248.00

Under this category were furnished Technical Services of a Chief Geologist at $500.00 per month and an assistant at $400.00 per month. The Chief Geologist, was Mr. T. L. Kesler, whose salary was not paid at the office performing the accounting under this contract. It is understood Mr. Kesler's salary is considerably more than $500.00 per month, and it is not considered practicable or necessary to make positive verification. Mr. W. E. Dill, the assistant geologist, performed the on-site work incidental to handling of cores and samples and shipping to the laboratory. The Operator billed for the salary of the assistant geologist at the rate specified in the contract; however this billing included the applicable taxes and insurance, which have been transferred by this audit to (7) Miscellaneous.

Payments of salary of Mr. W. E. Dill were verified by examination of payrolls for entire period and inspection of salary checks for August, October, December, 1953 and January, 1954. The DMEA Field Team have accepted the costs in this category as being fair and reasonable and necessary to attain the objectives of the contract. The costs claimed, auditor's disallowances, and accepted costs are as follows:

Chief Geologist Engineer	4 mo. @	$500.00	$2,000.00
Assistant Geologist Engineer	6 mo. @	400.00	2,400.00
Total costs claimed			$4,400.00
Less: Transfer to (7) Miscellaneous 1/			152.00
Total Accepted Cost			$4,248.00

1/ Total salary and bonus paid assistant geologist engineer from August 1, 1953 to January 31, 1954 was $2,248.00. Balance of $152.00 has been transferred to Payroll Taxes, and Insurance and Fringe Benefits.

(3) Operating Materials and Supplies $272.23

Under this classification in the contract is an estimated amount of $350.00 for core boxes and small tools. The Operator did not prepare accurate detailed schedules of the costs chargeable. At time of audit the various items of costs shown were reviewed in detail and acceptable costs traced through from documents to the cancelled checks issued in payment. The acceptable items classified as "Small Tools" consisted of two magnifiers, wrenches, tube, grinding plates, ax, brushes, pens, etc. "Core Boxes" consisted of lumber or completed core boxes as billed by the Elmer Lumber Company. The costs charged by months, auditors disallowances (detailed), and accepted costs are as follows:

	Costs Claimed	Audit Disallowance	Accepted Costs
Small Tools			
July 1953	$ 46.00	1/ $ 7.90	$ 38.10
August 1953	36.40	2/ (4.79)	41.19
September 1953	17.60	3/ 10.91	6.69
	$100.00	$14.02	$ 85.98
Add: Ice Box transferred from "Core Boxes"	10.50	____	10.50
Totals	$110.50	$14.02	$ 96.48
Core Boxes			
August 1953	$ 20.46	$	$ 20.46
September 1953	155.29		155.29
October 1953	44.00	4/ 33.50	10.50
	$219.75	$33.50	$186.25
Less: Ice Box transferred to Small Tools	(10.50)	____	(10.50)
Totals	$209.25	$33.50	$175.75
Total Operating Materials & Supplies	$319.75	$47.52	$272.23

1/ Pegmatite Reports disallowed.

2/ Undercharge. Allowable items exceeded billings.

3/ One Timkin Bearing $2.42; 1 Bag Cement $1.30; Aerosseal breakers and other auto repair $1.62; 30 Blueprints $4.50; unaccounted for $1.07.

4/ Three pieces 2½" black pipe $33.66, less undercharge of $.16

(4) Operating Equipment $540.00

Operating Equipment charged against this contract consisted of depreciation allowance for a 1½ ton truck furnished through use of a Chevrolet truck rented by the Operator from the Victory Chevrolet Company from August 10 to October 23, 1953 for $416.12. Thereafter the Operator furnished a 1953 Ford 1½ ton truck purchased on October 23, 1953 from the Plank Motor Company, for $2,653.53. The Operator charged against this contract the $30.00 per week allowable maximum provided in the contract from August 10, 1953 to December 31, 1953. The total of $540.00 charged

is allowed under the contract, and is considered fair and reasonable under the terms thereof. Payments for rental of the Chevrolet and purchase of the Ford were verified by reference to the billings and cancelled checks issued in payment.

(5) Initial Rehabilitation and Repairs

Not applicable to this contract.

(6) New Buildings, Improvements, etc.

Not applicable to this contract.

(7) Miscellaneous $4,480.49

The total costs claimed, and accepted within this category are as follows:

	Accepted Costs
Accounting	$ 320.00
Sampling and Analysis	4,008.49
Payroll Taxes	53.35
Insurance and Fringe Benefits	98.65
	$4,480.49

Accounting was performed by Mr. D. R. Smith, plant accountant at the Kings Mountain plant, at a rate of $40.00 per month for 8 months. This is considered fair and reasonable for the work performed.

Sampling and analysis included the assembling and preparation of samples, shipping to the Company laboratory in Exton, Pennsylvania and performing wet and spectrographic tests for columbium, tantalum, beryl and tin. There were 121 core samples, 40 sludge samples and 39 samples from the trenches. Costs of sampling, crushing and shipping performed at Kings Mountain, were estimated by determining time required for one of each type of sample. Of the total cost of $4,008.49, the principal item is $3,046.00 in costs billed from the Exton, Pennsylvania laboratory. These costs were covered by monthly journal entries clearing laboratory costs monthly against the work performed during that month. The costs per assay averaged considerably lower than the rates for similar work performed by the Government. They are considered fair and reasonable by the DMEA Field Team, and are accepted.

Payroll Taxes and Insurance and Fringe Benefits are acceptable on the salary paid to W. E. Dill. As the amount transferred from salary does not exceed the amount calculated at the applicable rates, the amounts of $53.35 and $98.65, respectively, are accepted as allowable costs.

IV CONCLUSION

This audit has disclosed that all costs, as charged to this project, with the exception of the disallowances made under (3) Operating Materials and Supplies of the preceding section of this report, are reasonable and proper under the terms of the contract, including the Exhibit "A" as amended. The findings have been discussed with Mr. D. R. Smith, plant accountant and Mr. Thomas L. Kesler, chief geologist, who was in actual charge of the exploration.

The adjustments between Items of Costs, as shown on the July 1954 MF-104, the recommended disallowances, and approved amounts, are summarized as follows:

Items of Cost	Totals July 1954 MF-104	Distribution Corrected	Disallowed by Audit	Accepted Costs
(1) Agreed Unit Costs:				
Diamond Drilling NX Core @ $7.80 ft.	$ 7,035.60	$ 7,035.60	$	$ 7,035.60
Diamond Drilling BX Core @ $7.00 ft.	5,817.70	5,817.70		5,817.70
Non-Core Drilling @ $2.35 ft.	861.28	861.28		861.28
Channeling @ $.90 ft.	379.80	379.80		379.80
(1) Independent Contracts				
Bulldozing @ $100/day	100.00	100.00		100.00
(2) Labor and Supervision				
Technical Services	4,400.00	4,248.00		4,248.00
(3) Operating Materials and Supplies				
Small Tools	100.00	110.50	14.02	96.48
Core Boxes	219.75	209.25	33.50	175.75
(4) Operating Equipment				
Depreciation	540.00	540.00		540.00
(7) Miscellaneous				
Accounting	320.00	320.00		320.00
Sampling & Analysis	4,008.49	4,008.49		4,008.49
Payroll Taxes		53.35		53.35
Insurance and Fringe Benefits		98.65		98.65
Totals	$23,782.62	$23,782.62	$47.52	$23,735.10

July 20, 1954

B. J. Brekhus, Auditor

Docket Copy

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EXPLORATION PROJECT CONTRACT

Docket No. DMEA-2841

FOOTE MINERALS COMPANY

Amendment No. 6

Contract Idm-E 523, DMEA-2841, dated 18th day of May 1953, as amended, between the United States of America, acting through the Department of the Interior, Defense Minerals Exploration Administration, hereinafter called the "Government," and Foote Mineral Company, 18 W. Chelten Avenue, Philadelphia, Penna., hereinafter called the "Operator", is further amended:

Article 3, is amended to provide "that the Operator bring the project to completion within a period of thirteen (13) months from the date of this contract." Instead of eleven (11) months as written in amendment No. 5, dated March 3, 1954.

This amendment shall not be construed to increase the estimated total cost of the project, the aggregate total amount which the Government may be required to contribute, nor the amount of any item designated as "allowable maximum."

April 13, 1954.

FOOTE MINERAL COMPANY

By [signature]

[redacted]

By [signature]
Acting, Executive Officer
DMEA Field Team, Region VII

Rubin 4/2/54

EXPLORATION PROJECT CONTRACT

Docket No. DMEA-2841

FOOTE MINERALS COMPANY

AMENDMENT No. 5

Contract Idm-E 523, DMEA-2841, dated the 18th day of May 1953 between the United States of America, acting through the Department of the Interior, Defense Minerals Exploration Administration, hereinafter call the "Government," and Foote Minerals Company, 18 W. Chelten Avenue, Philadelphia, Pennsylvania, hereinagter called the "Operator" is amended as follows:

Article 3, is amended to provide that "The Operator bring the project to completion within a period of eleven (11) months from the date of this contract." Instead of ten (10) months as written in Amendment No. 3, dated October 30, 1953.

This amendment shall not be construed to increase the estimated total cost of the project, the aggregate total amount which the Government may be required to contribute, nor the amount of any item designated as "allowable maximum."

Executed in sextuplicate this 3rd day of March 1954.

FOOTE MINERAL COMPANY

By [signature]

THE UNITED STATES OF AMERICA

By Robert A. Lawrence

EXECUTIVE OFFICER
DMEA REGION VII

Docket copy

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EXPLORATION PROJECT CONTRACT
FOOTE MINERAL COMPANY
DOCKET NO. DMEA-2641

AMENDMENT NO. 4

It is agreed this 1st day of March, 1954, between the United States of America, acting through the Department of the Interior, Defense Minerals Exploration Administration, and Foote Mineral Company, that Exploration Project Contract I4n-2423, Docket No. DMEA-2641, dated May 18, 1953, as amended, be further amended, effective May 18, 1953, as follows:

In Amendment No. 3:

1. At the end of paragraph numbered 3(A), add the following sentence:

"Noncoring, roller-bit drilling may be used to start diamond drill holes."

2. Under the heading "Agreed Estimated Unit Costs," under paragraph 3(B), add at the end of the parenthesis following the first item, the following sentence:

"Where noncoring, roller-bit drilling is used, the unit cost shall be $2.35/ft."

This amendment shall not be construed to increase the estimated total cost of the project, the aggregate total amount which the Government may be required to contribute, nor the amount of any item designated as "allowable maximum."

Executed in sextuplicate the day and year first above written.

THE UNITED STATES OF AMERICA

By C. J. Mitteider
Acting Administrator, Defense Minerals Exploration Administration

Hoffland
Chamberlin

FOOTE MINERAL COMPANY

By L. B. Bird

Docket Copy

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
OCT 23 1953

EXPLORATION PROJECT CONTRACT
FOOTE MINERAL COMPANY
DOCKET NO. DMEA-2841

AMENDMENT NO. 3

It is agreed this 30th day of October, 1953, between the United States of America, acting through the Department of the Interior, Defense Minerals Exploration Administration, and the Foote Mineral Company, each acting in consideration of the agreement of the other to the terms hereinafter set forth, that Exploration Project Contract Idm-E523, Docket No. DMEA-2841, dated May 18, 1953, as amended, between the parties hereto, be further modified and amended as of the date of the said contract, as follows:

1. Under Article 3, the words "six (6) months" are deleted and the words "ten (10) months" are substituted therefor.

2. In lieu of Article 9 of the contract form, the provisions of Annex I, attached hereto and made a part hereof, are substituted. However, the provisions of Article 13 remain a part of the contract.

3. In Exhibit "A"--

(A) Under the heading "Description of the Work," the third paragraph, as amended by Amendment No. 1 dated June 19, 1953, is deleted, and the following substituted therefor:

"The dikes in Tracts 3 and 4 will be explored by seven or more diamond drill holes having a total length not in excess of 2100 feet, yielding cores having 2-1/8 inch diameter where practical and 1-5/8-inch diameter where a more efficient operation and better recovery of sludge samples are indicated."

(B) Under the heading "Estimated Costs of the Project," everything is deleted and the following is substituted therefor:

Agreed Estimated Unit Costs

Diamond Drilling 2,100 feet @ $7.80/ft. (This unit cost is based on a 2-1/8" core. Where 1-5/8" core is substituted, the unit cost shall be $7.00/ft.)	$16,380.00	
Channeling 2,140 feet @ $0.90/ft.	1,926.00	$18,306.00

The Government will contribute to the costs of the diamond drilling and channeling on the basis of these agreed unit costs per foot, as they accrue for units of work actually performed in lieu of actual costs. The agreed unit costs include all costs of the work, except those items listed below, to the cost of which the Government will contribute on the basis of the actual costs as specified in Article 6(a) of the contract form. This work may be performed by independent contractor without reference to the provisions relating to independent contracts and contractors in Articles 4(a) and (b), and 6(a)(1) of the contract form.

Estimated Actual Costs

(*Indicates allowable maximum)

(1) **Independent Contracts**		
1 D8 - Bulldozer - 5 days @ $100/day* (This includes all costs of operations, supplies, maintenance, and transportation to and from site.)		$ 500.00*
(2) **Labor, Supervision, Consultants**		
1 Geologist-Engineer 4 mos.* @ $500/mo.*	$2,000.00*	
1 Geologist-Engineer helper 6 mos. @ $400/mo.	2,400.00	4,400.00
(3) **Operating materials and supplies**		
Core boxes	250.00	
Small tools	100.00	350.00

(4) Operating equipment

To be furnished by Operator:

1 pickup truck for 10 hrs. per week 18 weeks @ $30.00/wk. (This includes all costs of operation, supplies, and maintenance)		$ 540.00

(5) Rehabilitation and repairs

None

(6) New buildings, improvements, installations

None

(7) Miscellaneous

1 Accountant @ $40/mo. for 4 mos.	$160.00	160.00
200 assays for Columbium and tantalum @ $15.00*/assay	3,000.00*	
200 assays for beryllium @ $5.00*/assay	1,000.00*	
200 assays for tin @ $7.50*/assay	1,500.00*	5,500.00*

(8) Contingencies	744.00
Estimated Total Cost of the Project	$30,500.00*
Government Participation @ 90%	$27,450.00*

This amendment shall not be construed to increase the estimated total cost of the project, the aggregate total amount which the Government may be required to contribute, nor the amount of any item designated as "allowable maximum."

Executed in sextuplicate the day and year first above written.

THE UNITED STATES OF AMERICA

FOOTE MINERAL COMPANY

By Louis G. Elies

Louis G. Elies, Vice-President-Sales

By C. Mitteudorf

Administrator, Defense Minerals Exploration Administration

EXPLORATION PROJECT CONTRACT
POOLE MINERAL COMPANY
DOCKET NO. DMA-2041

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
NOV 23 1953

ANNEX I

The following provisions are in lieu of Article 9 :

Repayment by Operator.--a. Certification.--If at any time the Government considers that a discovery or development from which production may be made has resulted from the exploration work, the Government, at any time not later than six months after the Operator has rendered the final report and final account, may so certify in writing to the Operator. Such certification shall describe broadly or indicate the nature of the discovery or development.

b. Percentage royalty.--The Operator, or his successor in interest, shall pay to the Government a royalty on all minerals mined or produced from the land described in Article 2,--(1) regardless of any certification of discovery or development, from the date of the contract until the lapse of the time within which the Government may make such certification of discovery or development, or until the total net amount contributed by the Government, without interest, is fully repaid, whichever occurs first, unless the Government waives its right to a royalty; or (2) if the Government makes a certification of discovery or development, for a period of ten years (or other period fixed by this contract) from the date of the contract, or until the total net amount contributed by the Government, without interest, is fully repaid, whichever occurs first. Said royalty shall be a percentage of the net smelter returns, the net concentrator returns, or other net amounts realized from the sale or other disposition of any such production (including any bonuses), in whatever form disposed of, including ore, concentrates, or metal, as follows:

(a) One and one-half ($1\frac{1}{2}$) per cent of any such net amounts not in excess of eight dollars ($8.00) per ton.

(b) One and one-half ($1\frac{1}{2}$) per cent of any such net amounts, plus one-half ($\frac{1}{2}$) per cent of such net amounts for each additional full fifty cents ($0.50) by which such net amounts exceed eight dollars ($8.00) per ton, but not in excess of five (5) per cent of such net amounts.

(For instance: the percentage royalty on a net amount of five dollars ($5.00) per ton, would be one and one-half ($1\frac{1}{2}$) per cent; on a net amount of ten dollars ($10.00) per ton, three and one-half ($3\frac{1}{2}$) per cent.)

c. Definitions.--As here used, "net smelter returns", "net concentrator returns", and "other net amounts realized from the sale or other disposition", mean gross revenue from sales; or if not sold, the market value of the material after it is mined in the form in which and the place where it is held. In the case of integrated operations in which the material is not disposed of as such, these terms mean what is or would be gross income from mining operations for percentage depletion purposes in income tax determination.

d. Lien for Payment.--To secure the payment of its percentage royalty, the Government shall have and is hereby granted a lien upon the land described in Article 2 and upon any production of minerals therefrom, until the royalty claim is extinguished by lapse of time or is fully paid.

e. Notice to Purchasers.--The Operator shall notify any purchaser of the production of the Government's royalty interest, and shall authorize and direct the purchaser to pay the royalty directly to the Government and to furnish the Government with copies of the settlement sheets; but failure or refusal by the purchaser to comply shall not relieve the Operator of liability to pay any royalty falling due.

f. No Obligation to Produce.--This article is not to be construed as imposing any obligation on the Operator or the Operator's successor in interest to engage in any mining or production operations.

Docket Copy

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JUL 30 1953

OK: CEK 7/24/53 Approved

EXPLORATION PROJECT CONTRACT
FOOTE MINERAL COMPANY
Docket No. DMEA-2841

AMENDMENT No. 2

Contract Idm-E523, DMEA-2841, dated the 18th day of May 1953, between the United States of America, acting through the Department of the Interior, Defense Minerals Exploration Administration, hereinafter called the "Government," and Foote Mineral Company, 18 W. Chelten Avenue, Philadelphia, Pennsylvania, hereinafter call the "Operator" is amended as follows:

Article 3, is amended to provide that the Operator, within 90 days from the date of this contract shall commence work on a project..... instead of 60 days as provided in the original contract.

This amendment is necessary due to unforeseen delays in getting equipment for the project.

This amendment shall not be construed to increase the estimated total cost of the project, the aggregate total amount which the Government may be obligated to pay, or the percentage of the costs which the Government may be obligated to pay, under the provisions of Article 8 of the contract form.

July 13, 1953.

THE UNITED STATES OF AMERICA

By Robert A. Lawrence
Executive Officer, DMEA Field Team
Region VII

FOOTE MINERAL COMPANY

By Louis G. Bliss
Louis G. Bliss, Vice President-Sales

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EXPLORATION PROJECT CONTRACT
FOOTE MINERAL COMPANY
DOCKET No. DMEA-2841

AMENDMENT NO. I

It is agreed this 19th day of June 1953, between the United States of America, acting through the Department of the Interior, Defense Minerals Exploration Administration, and Foote Mineral Company, a corporation duly organized and existing under and by virture of the laws of the State of Pennsylvania, each acting in consideration of the other to the terms hereinafter set forth, that Exploration Project Contract Idm-8523, Docket No. DMEA-2841, dated May 18, 1953, be modified and amended as of the date of the contract, May 18, 1953 as follows:

In Exhibit "A"

(A) Under "Description of the Work" delete the third paragraph and substitute the following:

The dikes in Tract 3 and 4 will be explored by seven or more diamond drill holes having a total length not in excess of 2,100 feet, yielding cores having at least 2 1/8 inch diameter.

This amendment shall not be construed to increase the estimated total cost of the project, the aggregate total amount which the Government may be obligated to pay, or the percentage of the costs which the Government may be obligated to pay, under the provisions of Article 8 of the contract form.

THE UNITED STATES OF AMERICA

By Robert A. Lawrence
Executive Officer, DMEA Field Team
Region VII

FOOTE MINERAL COMPANY

By L. G. Bliss
L. G. Bliss, Vice President

June 19, 1953

xx

MF-200
(June 1951)
(Revised Feb. 1952)

Department of the Interior
Defense Minerals Administration
RECEIVED
MAY 26 1953

DOCKET No. DMEA 2841

COMMODITY Columbium-tantalum-beryl and tin

/Docket Copy
IDM-E 523

UNITED STATES OF AMERICA
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION

EXPLORATION PROJECT CONTRACT [1]

BL

IT IS AGREED this 18th day of May, 1953, between the United States of America, acting through the Department of the Interior, Defense Minerals Exploration Administration, hereinafter called the "Government," and [2] Foote Mineral Company, a corporation duly organized and existing 13 W. Chelten Avenue under and by virtue of the laws of the Philadelphia, Pa. State of Pennsylvania

hereinafter called the "Operator," as follows:

ARTICLE 1. *Authority for contract.*—This agreement is entered into under the authority of the Defense Production Act of 1950, as amended, pursuant to DMEA Order 1 entitled "Government Aid in Defense Exploration Projects."

ARTICLE 2. *Operator's property rights.*—With respect to ~~that certain land situated in~~ the mineral rights in the State of North Carolina, County of Cleveland, described as ~~follows~~ [3] Tracts 3 and 4, shown on the map attached hereto and made a part hereof and entitled "Exhibit B - Foote Mineral Co. Exton, Pa." These two tracts are more particularly described in a lease dated December 10, 1949, from L. M. Williams, et al. to the Operator. Tract 3 contains 99.6 acres and tract 4 contains 289.54 ~~xx the Operator represents and undertakes xxxx~~ as indicated on plats thereof recorded in Plat Book 5, pages 77 and 78 respectively in the office of the Register of Deeds ~~xxxxx (a) That the Operator is the owner in possession and entitled to possession and entitled to possession of the property, subject only to the following claims, liens, or encumbrances, none of which is in default: Bessemer City, N. C. xxxxxx~~ of Cleveland County, N. C.

the Operator represents and undertakes:

(*b*) That the Operator is a lessee, in possession and entitled to possession, and the Owner's Consent to Lien is attached.

The Operator shall devote the land and all existing improvements, facilities, buildings, installations, and appurtenances to the purposes of the exploration project without any allowance for the use, rental value, depreciation, depletion, or other cost of acquiring, owning, or holding possession thereof.

ARTICLE 3. *Exploration project.*—The Operator, within 60 days from the date of this contract shall commence work on a project of exploration for [5] Columbium-tantalum-beryl, and tin

in or upon the described land; and shall bring the project to completion within a period of six (6) months from the date of this contract. The work to be performed is more fully described in Exhibit "A" attached hereto, which, with any maps or drawings thereto attached, are made a part of this contract. The Government will contribute to the cost of this work as hereafter provided.

ARTICLE 4. *Performance of the work.*—(*a*) *Operator's responsibility.* The work shall be performed efficiently, expertly, in a workmanlike manner, in accordance with good mining standards and State regulations for health and safety and for workmens' compensation and employers' liability insurance, with suitable and adequate equipment, materials, and labor, to bring the project to completion within the time fixed. To the extent specified in Exhibit "A," attached hereto, the work may be performed by independent contractor or contractors; and work not specified in Exhibit "A" for performance by independent contractor may nevertheless be so performed upon amendment of Exhibit "A," as agreed to by the parties, to state the work to be so performed and the estimated unit costs thereof, as provided hereafter.

(*b*) *Independent contracts.*—Any independent contract for the performance of work shall be on a unit-price basis (such as per foot of drilling, per foot of drifting, per hour of bulldozer operations, per cubic yard of material moved), or on some basis that will indicate the amount due for work performed at any stage of the work to be performed under such independent contract. The Government shall not be nor be considered to be a party to any such independent contract, and the Government's right to terminate the exploration project contract under any of its provisions shall not in any manner be affected by reason of any such independent contract. If the reference in Exhibit "A" to any such independent contract states that the Government's approval thereof is required, the Government may refuse to participate in the cost thereof unless and until it has given its written approval of the independent contract.

(*c*) *Government may inspect.*—The Government shall have the right to enter and observe and inspect the work at all reasonable times, and the Operator shall provide the Government with all available means for doing so. The Government may consult with and advise the Operator on all phases of the work.

ARTICLE 5. *Estimated costs of the project.*—A statement of the estimated cost of the project is set forth in Exhibit "A," attached hereto. Except insofar as any item of requirement or the estimated cost thereof set forth in Exhibit "A" is there or elsewhere designated as an "allowable maximum," such items of requirement and of related cost are estimates only, and may be exceeded to the extent that the Government may from time to time approve for the most economic and beneficial performance of the work within the limitation of the total aggregate estimate of costs. The Government's approval of any such excess over the estimate for an item of requirement or related cost will be signified by its approval and payment of any invoice or voucher for payment which expressly calls attention to such excess. Items expressly designated in Exhibit "A" or elsewhere as "allowable maximum," and the total aggregate estimated cost are limitations, and any excess therein will be for the sole account of the Operator in which the Government will not participate.

ARTICLE 6. *Allowable costs of the project.*—(*a*) The costs of the project in which the Government will participate are limited to the following:

(1) *Independent contracts.*—Payments to independent contractors under independent contracts listed in Exhibit "A." The estimated cost of any work to be performed under an independent contract is or shall be included in the estimate of costs in Exhibit "A" in terms of the estimated numbers of units of work to be performed, the estimated amount to be paid per unit, and the estimated total amount to be paid to the independent contractor, and such estimates shall be allowable maximums above which the Government will not contribute. Regardless of the provisions of any such independent contract, the Government will participate in the payments to the independent contractor only on account of work actually performed and that conforms with the provisions of the exploration project contract, and only to the extent that the Government deems the unit prices for the work under the independent contract to be reasonable and necessary. No such independent contract shall have the effect of increasing the estimated total cost of the exploration project contract nor the maximum amount which the Government will pay as provided in the exploration project contract.

(2) *Labor, supervision, consultants.*—Labor, supervision and technical services (including engineering and geological consultants), a schedule of which is included in the estimate of costs set forth in Exhibit "A." The requirements and related estimated costs for supervision and technical services are allowable maximums.

(3) *Operating materials and supplies.*—Necessary materials and supplies including items of equipment costing less than $50.00 each, and power, water, and fuel, a schedule of which is included in the estimate of costs in Exhibit "A."

(4) *Operating equipment.*—Any operating equipment to be rented or purchased, or which is owned and will be furnished by the Operator, with the estimated rental, purchase price, or the allowable depreciation, as the case may be, a schedule of which is included in Exhibit "A." Any items listed as owned and to be furnished by the Operator, and related ~~initial~~ allowable depreciation, are allowable maximums.

(5) *Rehabilitation and repairs.*—Any necessary initial rehabilitation or repairs of existing buildings, installations, fixtures, and movable operating equipment, now owned by the Operator and to be devoted to the purposes of the exploration contract, a schedule of which is included in the estimate of costs set forth in Exhibit "A." These items are allowable maximums.

(6) *New buildings, improvements, installations.*—Any necessary buildings, fixed improvements, or installations to be purchased, installed, or constructed for the purposes of the exploration work, with the estimated cost of each, a schedule of which is included in the estimate of costs in Exhibit "A." All of these items are allowable maximums.

(7) *Miscellaneous.*—Repairs to and maintenance of operating equipment (not including initial rehabilitation or repairs of the Operator's equipment), analytical work, accounting, workmen's compensation and employers' liability insurance and payroll taxes.

(8) *Contingencies.*—Such other necessary, reasonable direct costs of performing the exploration work, within the limit of the total aggregate estimate of costs, whether or not included in any schedule of costs in Exhibit "A," as may be approved by the Government in the course of the work, as indicated by its approval and payment of invoices and vouchers.

[1] If sufficient space is not provided in any blank, use an extra sheet of paper and refer to it in the blank.
[2] State name, address, and nature of organization if any.
[3] Give legal description or enough to identify the property, particularly excluding any land or interest therein to which the Government's lien is not to attach or the production from which is not to be subject to the Government's percentage royalty.
[4] Strike out the provision not applicable.
[5] Name of mineral or minerals.

(*b*) The Government's payments in all cases will be based on actual, necessary costs (including contract unit prices) incurred not in excess of any "allowable maximum," and not in excess of the fixed percentage of the total aggregate estimated cost. Costs will be considered to be incurred only as they are or become due and payable.

(*c*) No items of general overhead, corporate management, interest, taxes (other than payroll and sales taxes) or any other indirect costs, or work performed or costs incurred before the date of this contract, shall be allowed as costs of the project in which the Government will participate.

ARTICLE 7. *Reports, accounts, audits.*—(*a*) *Progress reports.* The Operators shall provide the Government with monthly reports of work performed and costs (including contract unit prices) incurred under the contract, in quintuplicate (five copies), upon forms provided by the Government. These progress reports shall be certified by the Operator, and shall constitute both the Operator's invoice of costs incurred on the project during the period covered by the report and his voucher for repayment by the Government, unless the Government requires the use of a standard voucher form with invoice attached. Progress reports shall include surface and/or underground engineering-geological maps or sketches showing the progress of the exploration, with assay-reports on samples taken concurrently with the advance in mineralized ground.

(*b*) *Final report.*—Upon completion of the exploration work or termination of the contract the Operator shall provide the Government with an adequate geological and engineering report, in quintuplicate (five copies), including an estimate of ore reserves resulting from the exploration work.

(*c*) Compliance with requirements.—If, in the opinion of the Government, any of the Operator's reports are insufficient or incomplete, the Government may procure the making or completion of such reports and attachments as an expense of the exploration work; and the Government may withhold approval and payment of any vouchers depending upon insufficient or incomplete reports.

(*d*) *Accounts and audits.*—The Operator shall keep suitable records and accounts of operations, which the Government may inspect and audit at any time. The Government may at any time require an audit of the Operator's records and accounts by a certified public accountant, the cost thereof to be treated as a cost of the project. The Operator shall keep and preserve said records and accounts for at least 3 years after the completion of the project or the termination of this contract. Upon the completion of the project or termination of the contract the Operator shall render a final account as provided in Article 12.

ARTICLE 8. *Payments by the Government.*—(*a*) The Government will pay 90 percent of the allowable costs incurred, as they accrue, in an aggregate total amount not in excess of $27,450.00, which is 90 percent of $30,500.00, the agreed, estimated total cost of the project in which the Government will participate; *Provided,* that until the Operator's final report and final accounting have been rendered to the Government, and any final auditing required by the Government has been made, and a final settlement of the contract has been made, the Government may withhold from the last voucher or vouchers such sums as it sees fit not in excess of ten (10) percent of the maximum total which the Government might have been called upon to pay under the terms of the contract.

(*b*) The Government may make any payment or payments direct to independent contractors and to suppliers, for the account of the Operator, rather than to the Operator.

ARTICLE 9. *Repayment by Operator.*—(*a*) If, at any time, the Government considers that a discovery or a development from which production may be made has resulted from the exploration work, the Government, at any time not later than 6 months after the Operator has rendered the required final report and final account, may so certify in writing to the Operator. The certification shall describe broadly or indicate the nature of the discovery or development. In the event of such certification, any minerals mined or produced from the land described in Article 2 within 10 years from the date of this contract, including any mined or produced before the certification, shall be subject to a percentage royalty which the Operator or his successor in interest shall pay to the Government, upon the net smelter returns, the net concentrator returns, or other net amounts realized from the sale or other disposition of any such production, in whatever form disposed of, including ore, concentrates, or metal, until the total amount contributed by the Government, without interest, is fully repaid, or said 10 years have elapsed, whichever occurs first, as follows: See also Article 13

(1) One and one-half (1½) percent of any such net amounts not in excess of eight dollars ($8.00) per ton.

(2) One and one-half (1½) percent of any such net amounts, plus one-half (½) percent of such net amounts for each additional full fifty cents ($0.50) by which such net amounts exceed eight dollars ($8.00) per ton, but not in excess of five (5) percent of such net amounts.

(For instance: The percentage royalty on a net amount of five dollars ($5.00) per ton would be one and one-half (1½) percent; on a net amount of ten dollars ($10.00) per ton, three and one-half (3½) percent.)

(*b*) As here used, "net smelter returns," "net concentrator returns," and "other net amounts realized from the sale or other disposition," mean gross revenue from sales; or if not sold, the market value of the material after it is mined in the form in which and the place where it is held. In the case of integrated operations in which the material is not disposed of as such, these terms mean what is or would be gross income from mining operations for percentage depletion purposes in income-tax determination.

(*c*) To secure the payment of its percentage royalty, the Government shall have and is hereby granted a lien upon the land described in Article 2 and upon any production of minerals therefrom, until the royalty claim is extinguished by lapse of time or is fully paid.

(*d*) This article is not to be construed as imposing any obligation on the Operator or the Operator's successor in interest to engage in any mining or production operations.

ARTICLE 10. *Assignment, transfer, or loss of Operator's interest.*—Without the written consent of the Government, the Operator shall not assign or otherwise transfer or hypothecate this contract or any rights thereunder. The Operator shall not make any voluntary nor permit any involuntary transfer or conveyance of the Operator's rights in the land described in Article 2, without making suitable provision for the preservation of the Government's right to a percentage royalty on production and lien for the payment thereof; *Provided,* that mere failure by the Operator to maintain the Operator's rights in the land, without any consideration running to the Operator other than relief from the cost of maintaining such rights (as by surrender of a leasehold, failure to perform assessment work, or failure to exercise an option), coupled with complete abandonment by the Operator of all interest in or operations on the land for a period of 10 years from the date of this contract, shall not constitute such a transfer or conveyance. Should the Operator make or permit any transfer or conveyance in violation of this provision, the Operator shall be and remain liable for payment to the Government of the same amounts, at the same times, as would have been paid under the terms of the percentage royalty on production. If for any reason the net smelter returns, net concentrator returns, or other net amounts realized from the sale or other disposition of such production are not available as a means of measuring the amount of the Operator's liability, the amount thereof shall be estimated as well as may be, and in the event of dispute as to such estimates, the determination thereof by the Administrator of Defense Minerals Exploration Administration or by his successor shall be final and binding upon the Operator.

ARTICLE 11. *Title to and disposition of property.*—All facilities, buildings, fixtures, equipment, or other items costing more than $50.00 each, paid for or purchased with funds contributed jointly by the Operator and the Government, although title may be taken in the name of the Operator, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the completion of the work or the termination of the contract shall be disposed of promptly by the Operator for the joint account of the Government and the Operator, either by return to the vendor, by sale to others, or purchase by the Operator at a price at least as high as could otherwise be obtained, as may appear to be for the best interest of the Government, unless the Government, in writing, waives its interest in any such item. If necessary to accomplish such disposition, the Operator shall dismantle, sever from the land, and remove any such item, the cost thereof to be for the joint account of the parties in proportion to their respective interests. If the Operator, within 90 days after the receipt of written notice from the Government, fails, neglects, or refuses to dispose of such property, the Government may itself enter upon the land, take possession of, and remove and dispose of any such property as above provided.

ARTICLE 12. *Termination and completion.*—The Government may, at any time, by written notice to the Operator, terminate this contract: (*a*) If the Operator fails to provide his share of the money necessary to prosecute operations pursuant to the terms of the contract; (*b*) if the Operator, in the opinion of the Government, fails to prosecute operations pursuant to the terms of the contract; or (*c*) if in the opinion of the Government, operations up to the time of the notice have not indicated the probability of making any worth while discovery and in the opinion of the Government further operations are not justified. Upon the completion of the project or any termination of the contract the Operator shall dispose of any remaining materials, supplies, facilities, buildings, fixtures, and equipment in which the Government has an interest, for the joint account of the Operator and the Government in the proportion of their respective interests; shall render to the Government a full and final accounting of his operations under the contract and his expenditures of money; and shall pay to the Government its pro rata share of any money remaining.

ARTICLE 13. *Changes and added provisions.* The cost of determining the lithium content of the samples required in Exhibit "A" is to be borne solely by the Operator and the evaluation of the lithium minerals produced by the concentrating mill at the mine will be the current market quotation for the lithium content

Executed in sextuplicate the day and year first above written.

THE UNITED STATES OF AMERICA

By O. Mitteedy
Administrator, Defense Minerals Exploration Administration

FOOTE MINERAL COMPANY
(Operator)

By Louis G. Bliss
Louis G. Bliss - Vice President-Sales

I, Carolyn M. Crichton, certify that I am the Assistant secretary of the corporation named as Operator herein; that Louis G. Bliss, who signed this contract on behalf of the Operator, was then Vice President - Sales of said corporation; that said contract was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

Carolyn M. Crichton

[CORPORATE SEAL]

U. S. GOVERNMENT PRINTING OFFICE 16—66328-1

EXPLORATION PROJECT CONTRACT
FOOTE MINERAL COMPANY
DOCKET NO. DMEA-2841

EXHIBIT "A"

Description of the Work

The object of the work is to explore for columbium, tantalum, beryl and tin in pegmatite dikes in the North Carolina spodumene belt.

The location of the work is approximately shown on the map attached hereto and entitled "Exhibit B - Foote Mineral Co. Exton, Pa."

The dikes in Tracts 3 and 4 will be explored by seven diamond drill holes having a total length not in excess of 2,100 feet, yielding cores having at least 2 1/8 inch diameter.

The cores will be stored in standard core boxes properly labeled, and studied, sampled and assayed, and copies of all assay returns obtained by the Operator will be provided to the Government including those of lithium. The sludge will be sampled in accordance with standard practice. All cores will be available to the Government for inspection.

The outcrops of the dikes will be exposed and cleared by bulldozer and hand work.

The outcrop of the dikes will be sampled by cutting channels at least 6 inches wide by 6 inches deep for a total length not in excess of 2,140 feet. The channel work will include cleaning the surface of the dikes, gathering and preparing the samples.

The contents of columbium, tantalum, beryl and tin will be determined by the spectroscope or wet method. Samples may be taken of the ore or of concentrates produced from the ore.

The location, direction, and extent of all work under this contract, including sampling and assaying, is subject to the approval of the Government.

Estimated Costs of the Project
(*Indicates allowable maximum)

Agreed Estimated Unit Costs

Diamond Drilling 2,100 feet @ $7.80/foot	$16,380.00	
Channeling - 2,140 feet @ $0.90/foot	1,926.00	
		$18,306.00

The Government will contribute to the costs of the diamond drilling and channeling on the basis of these agreed unit costs per foot, as they accrue for units of work actually performed in lieu of actual costs. The agreed unit costs include all costs of the work, except those items listed below, to the cost of which the Government will contribute on the basis of the actual costs as specified in Article 6(a) of the contract form. This work may be performed by independent contractor without reference to the provisions relating to independent contracts and contractors in Articles 4(a) and (b), and 6(a)(1) of the contract form.

Estimated Actual Costs

(1)	**Independent contracts**		
	1 D8 - Bulldozer - 5 days @ $100/day* (This includes all costs of operations, supplies, maintenance, and transportation to and from site.)		$ 500.00*
(2)	**Labor, supervision, consultants**		
	1 Geologist-Engineer - 4 mos. @ $500/mo.*	$2,000.00*	
	1 Geologist-Engineer helper - 4 mos. @ $400/mo.	1,600.00	3,600.00
(3)	**Operating materials and supplies**		
	Core boxes	250.00	
	Small tools	100.00	350.00

(4) Operating equipment

To be furnished by Operator

1 pickup truck - 2 hrs. per day - 5 day week for 6 weeks @ $3.00/hr. (This includes all costs of operations, supplies, maintenance, and transportation to and from site.)		$ 180.00

(5) Rehabilitation and repairs

None

(6) New buildings, improvements, installations

None

(7) Miscellaneous

1 Accountant @ $40/mo. for 4 mos.	$160.00	160.00
200 assays for Columbium and tantalum @ $15.00*/assay	3,000.00*	
200 assays for beryllium @ $5.00*/assay	1,000.00*	
200 assays for tin @ $7.50/* assay	1,500.00*	5,500.00*

(8) Contingencies 1,904.00

Estimated Total Cost of the Project	$30,500.00*
Government Participation 90%	$27,450.00*

MF-203

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 North Carolina, County of Cleveland, described [redacted] [redacted]/

in a Lease dated the 10th day of December, 1949, and recorded in Book 6-B, Page 606, official records of said County,

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

2/ FOOTE MINERAL COMPANY

hereinafter called the "Operator"; and

WHEREAS, under certain provisions of said contract which are set forth on the reverse side hereof, the Government is entitled to a percentage royalty on production and to certain other 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 to enter into same, undertakes and agrees as follows:

1. The Government's equity in and right to dismantle, sever, take possession of, and remove and dispose of facilities, buildings, fixtures, equipment, or other items as provided in the contract, or any amendment thereof, shall prevail over and be prior and superior to any conflicting or adverse rights of the undersigned, and the Government is authorized to enter upon the land for such purposes.

2. To secure the payment to the Government of the percentage royalty on production3/ provided for under the terms of said exploration project contract, or any amendment thereof which does not increase the maximum amount of the Government's claim here stated or alter the provisions for repayment, there is hereby granted to the Government a lien upon the land herein described and upon any production of minerals therefrom, until the royalty claim is fully paid in the amount of the Government's contribution, not in excess of 4/$ _____, or ten years have elapsed from the date of the 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 said contract. This agreement shall be binding upon the heirs, executors, administrators, successors, and assigns of the undersigned.

Dated this 11 day of February, 1953.

L. M. Williams [Seal]

Lena B. Williams [Seal]
Lena B. Williams

Jean Cole Hatcher [Seal]
Jean Cole Hatcher

Rube Hatcher (SEAL)
Rube Hatcher

(SEAL)

Emily Cole Hovis (SEAL)
Emily Cole Hovis

Robert A. Hovis (SEAL)
Robert A. Hovis

Frances Cole Culp (SEAL)
Frances Cole Culp

B. B. Culp (SEAL)
B. B. Culp

1/ Either (a) insert the legal description of the land, or (b) strike out the words "as follows" and insert "in a lease [or contract, deed, or other document] dated _____, and recorded in book _____ page _____ official records of said county." If (b) is used, the book and page of recordation cannot be dispensed with. If the space provided is insufficient, use an Annex, and refer to the Annex in the space.

2/ Insert the name of the Operator as it will appear in the exploration project contract.

3/ Mining or production from the land is not required, and in the absence of production there is no obligation to repay the Government.

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

RELEVANT CONTRACT PROVISIONS

Repayment by Operator. (a) If, at any time, the Government considers that a discovery or a development from which production may be made has resulted from the exploration work, the Government, at any time not later than six months after the Operator has rendered the required final report and final account, may so certify in writing to the Operator. The certification shall describe broadly or indicate the nature of the discovery or development. In the event of such certification, any minerals mined or produced from the land described in Article 2 within 10 years from the date of this contract, including any mined or produced before the certification, shall be subject to a percentage royalty which the Operator or his successor in interest shall pay to the Government, upon the net smelter returns, the net concentrator returns, or other net amounts realized from the sale or other disposition of any such production, in whatever form disposed of, including ore, concentrates, or metal, until the total amount contributed by the Government, without interest, is fully repaid, or said 10 years have elapsed, whichever occurs first, as follows:

(1) One and one-half (1½) per cent of any such net amounts not in excess of eight dollars ($8.00) per ton.

(2) One and one-half (1½) per cent of any such net amounts, plus one-half (½) per cent such net amounts for each additional full fifty cents ($0.50) by which such net amounts exceed eight dollars ($8.00) per ton, but not in excess of five (5) per cent of such net amounts.

(For instance: the percentage royalty on a net amount of five dollars ($5.00) per ton, would be one and one-half (1½) per cent; on a net amount of ten dollars ($10.00) per ton, three and one-half (3½) per cent.)

(b) As here used, "net smelter returns", "net concentrator returns", and "other net amounts realized from the sale or other disposition", mean gross revenue from sales; or if not sold, the market value, the market value of the material after it is mined in the form in which and the place where it is held. In the case of integrated operations in which the material is not disposed of as such, these terms mean what is or would be gross income from mining operations for percentage depletion purposes in income tax determination.

(c) To secure the payment of its percentage royalty, the Government shall have and is hereby granted a lien upon the land described in Article 2 and upon any production of minerals therefrom, until the royalty claim is extinguished by lapse of time or is fully paid.

(d) This article is not to be construed as imposing any obligation on the Operator or the Operator's successor in interest to engage in any mining or production operations.

Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items costing more than $50.00 each, paid for or purchased with funds contributed jointly by the Operator and the Government, although title may be taken in the name of the Operator, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the completion of the work or the termination of the contract shall be disposed of promptly by the Operator for the joint account of the Government and the Operator, either by return to the vendor, by sale to others, or purchase by the Operator at a price at least as high as could otherwise be obtained, as may appear to be for the best interest of the Government, unless the Government, in writing, waives its interest in any such item. If necessary to accomplish such disposition, the Operator shall dismantle, sever from the land, and remove any such item, the cost thereof to be for the joint account of the parties in proportion to their respective interests. If the Operator, within 90 days after the receipt of written notice from the Government, fails, neglects, or refuses to dispose of such property, the Government may itself enter upon the land, take possession of, and remove and dispose of any such property as above provided.

MF-103
(Revised April 1952)

UNITED STATES DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION

Form Approved.
Budget Bureau No. 42-R1035.2.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JAN 8 1953

APPLICATION FOR AID IN AN EXPLORATION PROJECT, PURSUANT TO DMEA ORDER 1, UNDER THE DEFENSE PRODUCTION ACT OF 1950, AS AMENDED

Not to be filled in by applicant

Docket No. DMEA-2841
Metal or Mineral
Date Received 1/8/53
Estimated Cost
Participation (Government %)

INSTRUCTIONS

1. *Name of applicant.*—(*a*) State here your full legal name, in the form in which you will wish to contract, and your mailing address: Foote Mineral Company, (Corporation)
18 W. Chelten Avenue,
Philadelphia 44, Pa.
Incorporated under the laws of the Commonwealth of Pennsylvania

(*b*) If other than an individual, add to your name above whether a corporation, partnership, etc., and the name of the State in which incorporated or otherwise organized.

(*c*) If a corporation, add to above statement, titles, names and addresses of officers. See attached page 1.

(*d*) If a partnership, add to the above statement the names and addresses of all partners.

2. *General.*—Read DMEA Order 1, "Government Aid in Defense Exploration Projects," before completing this application. Submit this application and all accompanying papers in quadruplicate (four copies), with your name and address on each sheet of the application and on all accompanying papers. Where sufficient space is not provided on the form for all required information, state it on an accompanying paper, with a reference in each case to the instruction to which it refers by number. Comply with all applicable instructions; or, if not applicable, so state. File the application with Defense Minerals Exploration Administration, Department of the Interior, Washington 25, D. C., or with the nearest field executive officer thereof.

3. *Applicant's property rights.*—(*a*) State the legal description of the land upon which you wish to explore, including all land which you possess or control that may be benefited by the exploration, and excluding any land or interest in land which is not to be included in the exploration project contract See attached page 2.

(*b*) State any mine name by which the property is known. Williams Property, Tracts 1,2,3,4.

(*c*) State your interest in the land, whether owner, lessee, purchaser under contract, or otherwise Lessee

(*d*) If you are not the owner, submit with this application a copy of the lease, contract, or other document under which you control the property. Copy of lease Exhibit 3. (d) attached

(*e*) If you own the land, describe any liens or encumbrances on it No ownership

(*f*) If the land consists of unpatented claims, add to the description above, the book and page numbers for each recorded location notice. No unpatented claims exist.

4. *Physical description.*—(*a*) Describe in detail any mining or exploration operations which have been or now are being conducted upon the land, including existing mine workings and production facilities. State your interest, if any, in such operations. Also describe accessibility of mine workings for examination purposes. See attached page 2.

(*b*) State past and current production, and ore reserves, if any, giving quantities and grades. " " "

(*c*) Describe the geologic features of the property, including mineralization, type of deposit (vein, bedded, etc.), and your reasons for wishing to explore. Illustrate with maps or sketches. Send with your application (but not necessarily as a part of it) any geologic or engineering report, assay maps, or other technologic information you may have, indicating on each whether you require its return to you. See attached page 3.

(*d*) State the facts with respect to the accessibility of the project: Access roads, distances to shipping, supply and residence points. See attached page 3.

(*e*) State the availability of manpower, materials, supplies, equipment, water, and power. See attached page 4.

see Exhibits in pocket

~~see maps (or exhibits) Nos. 1 thru 10 in pocket~~

5. *The exploration project.*—(*a*) State the mineral or minerals for which you wish to explore Columbite, Tantalite, Tin and Beryl.

(*b*) Describe fully the proposed work, including a map or sketch of the property showing a plan (and cross sections if needed) of any present mine workings, and the location of the proposed exploration work as related to such features as contacts, veins, ore-bearing beds, etc. See attached page 4.

(*c*) The work will start within 30 days and be completed within 4 months from the date of an exploration project contract.

(*d*) State the operating experience and background of the applicant with relation to the ability to carry out such exploration project, and also that of the person or persons who will supervise the operations. See attached page 4.

6. *Estimate of costs.*—Furnish a detailed estimate of the costs of the proposed work (you will have to use a separate sheet), under the following headings. Add the totals under all headings to give the estimated total cost of the project:

(*a*) *Independent contracts.*—(Note.—If the applicant does not intend to let any of the work to contractors, write "none" after this item. To the extent that the work is to be contracted, do not repeat the cost of the contract-work in subsequent items.) State the cost of any proposed independent contracts for the performance of all or any part of the work, expressed in terms of units of work (such as per foot of drilling, per foot of drifting, per hour of bulldozer operations, per cubic yard of material moved, etc.). See attached page 5.

(*b*) *Labor, supervision, consultants.*—Include an itemized schedule of numbers, classes and rates of wages, salaries or fees for necessary labor, supervision and engineering and geological consultants. See attached pages 5 and 6.

(*c*) *Operating materials and supplies.*—Furnish an itemized list, including items of equipment costing less than $50 each, and power, water and fuel. See attached page 6.

(*d*) *Operating equipment.*—Furnish an itemized list of any operating equipment to be rented, purchased, or which is owned and will be furnished by the Operator, with the estimated rental, purchase price, or suggested use-allowance based on present value, as the case may be. See attached page 6.

(*e*) *Rehabilitation and repairs.*—Furnish a detailed list showing the cost of any necessary initial rehabilitation or repairs of existing buildings, installations, fixtures, and movable operating equipment, now owned by the Operator and which will be devoted to the exploration project. None

(*f*) *New buildings, improvements, installations.*—Furnish a detailed list showing the cost of any necessary buildings, fixed improvements, or installations to be purchased, installed or constructed for the benefit of the exploration project. None

(*g*) *Miscellaneous.*—Furnish a detailed list showing the cost of repairs to and maintenance of operating equipment (not including initial rehabilitation or repairs of the Operator's equipment), analytical work, accounting, workmen's compensation and employers' liability insurance, and payroll taxes. See attached page 6.

(*h*) *Contingencies.*—Give an estimate of any necessary allowances for contingencies not included in the costs stated above.

NOTE.—No items of general overhead, corporate management, interest, taxes (other than payroll and sales taxes), or any other indirect costs, or work performed or costs incurred before the date of the contract, should be included in the estimate of costs.

7. (*a*) Are you prepared to furnish your share of the cost of the proposed project in accordance with the regulations on Government participation (Sec. 7, DMEA No. 1)? We are prepared to furnish our share of the

(*b*) How do you propose to furnish your share of the costs? cost which amounts to $2,684.10.

[X] Money [X] Use of equipment owned by you [ ] Other

Explain in detail on acompanying paper.

CERTIFICATION

The undersigned, whether as an individual, corporate officer, partner, or otherwise, both in his own behalf and acting for the applicant, certifies that the information set forth in this form and accompanying papers is correct and complete, to the best of his knowledge and belief.

Dated December 30, 1952

FOOTE MINERAL COMPANY
(Applicant)

By L. G. Bliss
L. G. Bliss, Vice President
18 W. Chelten Ave.,
Philadelphia 44, Pa.

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—66551-1

1. (c) Titles, names and addresses of officers.

Chairman of the Board - - - - - -	H. C. Meyer 9421 Meadowbrook Ave., Philadelphia 18, Pa.
President, Treasurer & Director -	Gordon H. Chambers 7909 St. Martins Lane, Philadelphia 18, Pa.
Secretary & Director - - - - - - -	Ernest G. Enck, Felicity Farm, Swedesford Rd., Gwynedd Valley, Pa.
Vice President in Charge of Sales & Director - - - - - - - - - -	L. G. Bliss, 607 Custis Road, Glenside, Pa.
Vice President in Charge of Production & Director - - - -	Felix B. Shay, 427 N. Walnut Street, West Chester, Pa.
Vice President in Charge of Research & Director - - - - -	S. C. Ogburn, Jr., 618 Woodleave Road, Bryn Mawr, Pa.
Director - - - - - - - - - - - - - -	Robert J. Lewis, Estabrook & Company, 40 Wall Street, New York 5, N. Y.
Assistant Secretary - - - - - - - -	Carolyn M. Crichton, 75 Slocum Street, Philadelphia 19, Pa.
Assistant Treasurer - - - - - - - -	Paul E. Rapp, 109 Cedarbrook Road, Ardmore, Pa.

3. (a) The land under consideration in this application shall be known as the Williams Property, Tracts 1, 2, 3, and 4. A legal description and identification of the tracts is contained in a lease between the Foote Mineral Company and L. M. Williams and wife, Lena B. Williams, Janie McClintock Cole, Jean Cole Hatcher and husband, Rube Hatcher, Emily Cole Hovis and husband, Robert A. Hovis, Frances Cole Culp and husband, B. B. Culp. This lease is attached and is known as Exhibit 3. (d). (See also Exhibit 4. (d)-1.

4. (a) To the best of our knowledge there have been no mining or exploration operations on the property under consideration other than one small pit dug approximately 15 years ago. There are no existing mining workings or production facilities available on these properties. The land is easily accessible for investigative purposes as is evidenced by the maps contained herein under Exhibits 4. (d)-1 and 5. (b).

(b) To the best of our knowledge there has been no past or current production. Ore reserves are not definitely known. However, as a result of work done and published by the U.S. Dept. of Interior under title of "The Tin-Spodumene Belt of the Carolinas" - A Preliminary Report - Geological Survey Bulletin 936-J, we have confidence that there are important reserves of Columbium, Tantalum, Tin and Beryl in these properties. From the similarity of the outcroppings of Spodumene, and that which has been proven in properties adjacent to the Williams Property, we have confidence that an exploration of the Williams Property will result in proving up reserves equal to those being currently worked by us at Kings Mountain, North Carolina at this time. It will be observed from the Geological Survey Bulletin 936-J, (Exhibit 4. (b)-1 attached) that the probabilities are that Columbite, Tantalite, Tin and Beryl are likely to be present in these properties in commercial quantities which can be economically beneficiated. Whereas the ore reserves present in the Williams tracts under consideration have not been proven, we have, during the past year-and-a-half been recovering Columbite and Tin from comparable rock in adjacent properties. Since the installation of facilities capable of beneficiating Tin-Columbite in September 1951 we have produced approximately 20 tons of each as a by-product to the beneficiation of Spodumene.

Exhibit 4. (b)-2 attached indicates the Beryllium content of Spodumene bearing pegmatites on the property we are currently working. It is our belief that comparable or superior concentrations of Beryl can be found on the Williams tracts.

4. (c) (1) The type of property on which we wish to conduct exploration is best described in Exhibit 4. (b)-1, "The Tin-Spodumene Belt of the Carolinas", Geological Survey Bulletin 936-J.

(2) Report of W. R. Griffitts of the U. S. Geological Survey, Exhibit 4. (b)-2, and letter from Dr. R. M. Foose, Exhibit 4. (c)-2 attached, are incident to our current holdings and operations which are adjacent to the Williams tracts. We do not have as definitive results from exploration on the Williams tracts.

(3) The reasons we wish to explore the Williams tracts are as follows:

a. The Government is seeking certain metals and minerals of strategic importance. The Government lists columbite, tantalite, tin and beryl as falling under the most important classification of these minerals and metals.

b. We are currently operating a flotation process located on our own land adjacent to the Williams tracts. This plant, capable of processing 350 tons per day is being operated for the recovery of Spodumene, Tin, Columbite and ultimately, Mica, Feldspar and Beryl. We have a keen interest in altering the flow sheet to include the recovery of Beryl after the metallurgy has been successfully worked out.

We realize that the type of rock we should process should be the richest rock in Tin, Columbite and Beryl. Thus, should exploration of the Williams property, Tracts 1, 2, 3, and 4, disclose that certain areas are richer in those minerals listed herein, our intent would then be to be more selective in our quarrying operations.

For these reasons we consider it of value to the Government, and to our own operations, to determine at the earliest possible date the reserves and analyses of rock available in the Williams tracts.

4. (d) It will be seen from the map, Exhibit 4. (d)-1 attached, that three of the tracts are bordered by public thoroughfares, the Southern Railroad is within easy hauling distance, our existing flotation plant is also within easy hauling distance. The whole area is within several miles of Kings Mountain, North Carolina.

4. (e) On adjacent properties we currently employ between 40 and 60 men and we consider the manpower problem to be easily solved. Not only can we draw on the farm districts in the area but from such towns as Kings Mountain, Gastonia and Charlotee, North Carolina.

Materials, supplies and equipment can be procured locally from Charlotte, Gastonia and Kings Mountain or can be hauled in by truck from more distant points, or by Southern Railroad.

Water and power -- We consider the water and power supply to be perfectly adequate to operate a flotation mill of over 5 times the size of current capacity. We have our own reservoir adjacent to the mill and we currently draw water from two creeks capable of delivering 600 gallons per minute. The electric power available is from Duke Power Company.

5. (b) Details of the location of the proposed exploration work are shown on map marked Exhibit 5. (b) attached.

5. (d) The Foote Mineral Company has been operating similar properties in the Kings Mountain area for the past 2-1/2 years. To date four different quarries have been exposed and mined. The rock from these quarries has been beneficiated in our flotation mill located on these properties which are adjacent to the Williams tracts.

The Foote Mineral Company has previously diamond drilled core holes to log the cores on its property adjacent to the Williams tracts.

Foote Mineral Company is acquainted with and well versed in the splitting and analyzing of the cores for such elements as Beryl, Columbium, Tin and Tantalite. The Company is also familiar with methods of exposure of ore bodies by trenching for purposes of delineating the ore bodies.

Mr. Felix B. Shay and Mr. Dudley R. Rainey of Foote Mineral Company are the two men who will supervise these operations. Their background of experience and capabilities are attached in Exhibits 5. (d)-1 and 5. (d)-2 respectively.

6. Estimate of costs.

(a) Independent contracts

Rentals - Diamond drilling will be done on a contract basis and all equipment will be furnished by the contractor for this operation. It is proposed to secure three bids and award contract to the lowest acceptable bidder.

Estimated cost - 2100'* - $5.75 ft. . . . . $ 12,075.
(This estimate includes the water pump to be supplied by contractor)

Channel - Estimated footage - 2140'
(Channeling to be accomplished in 4 locations shown as locations 57, 56,55 and 51. See Exhibit 5. (b)*

Rentals
1 D-8 bulldozer - $100. a day - 5 days . . 500.

Location	Drill Holes* No. Holes	Footage
57	2 at 300'	600
North of 56	1 at 400' 1 at 300'	700
55	1 at 200' 1 at 400'	600
51	1 at 200'	200
		2100

* Refer to Exhibit 5. (b)

(b) Labor, supervision, consultants

Foote labor for channeling - estimate one man hour per foot at 90¢ per hour, for 2140' . 1,926.

Supervision - one consulting geologist at $60. per day - required 30 days - plus travelling expenses estimated at $500. . . . . 2,300.

One mining engineer at $400. per month required 20% of the time . . . . . 320.

6. (b) (continued)

One draftsman at $1.75 per hour required 200 hours	$ 350.
One accountant at $400. per month, required 10% of the time	160.
One stenographer at $1. per hour, required 200 hours	200.
(c) Operating materials and supplies	
Core boxes	250.
Small tools	100.
Surveying equipment - book value $600. $10. depreciation per month - 4 months	40.
(d) Operating equipment	
Pick-up truck owned by Foote Mineral Company - 2 hours per day for 6 weeks at $3. per hour (5 day week)	180.
(g) Miscellaneous	
Analyses - 200 samples Beryllium determination at $5. ea. (spectrograph)	1,000.
200 samples Columbium-Tantalum determination at $15. ea.	3,000.
200 samples Tin determination at $10. ea.	2,000.
(h) Contingencies	2,440.
TOTAL	$ 26,841.

Sent 90% 24,156.90

C O P Y

EXHIBIT 3. (d)

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

NORTH CAROLINA

CLEVELAND COUNTY

L E A S E

THIS LEASE made this 10th day of December, 1949, by and between L. M. WILLIAMS and wife, LENA B. WILLIAMS, JANIE McCLINTOCK COLE (widow) by her Attorney-in-fact, JEAN COLE HATCHER (see power of attorney recorded in Book 5Q, page 640 of the Cleveland County Registry), JEAN COLE HATCHER and husband, RUBE HATCHER, EMILY COLE HOVIS and husband, ROBERT A. HOVIS, all of the Mecklenburg County, North Carolina, and FRANCES COLE CULP and husband, B. B. CULP, of Gaston County, North Carolina, hereinafter collectively called "Lessor", parties of the first part, and FOOTE MINERAL COMPANY, a corporation organized and existing under the laws of the Commonwealth of Pennsylvania and having its principal office and place of business in the City of Philadelphia, Pennsylvania, hereinafter called "Lessee", party of the second part,

W I T N E S S E T H:

1. For and in consideration of the sum of One Dollar ($1.00) to Lessor in hand paid by Lessee, the receipt whereof is hereby acknowledged, and also, in consideration of the rents or royalties hereinafter provided to be paid by Lessee to Lessor, Lessor does hereby grant, demise, lease and let exclusively unto Lessee the interests hereinafter specified in the tracts of land hereinafter more particularly described for the purpose of exploring, prospecting, investigating, drilling, quarrying, mining, processing, transporting, selling, manufacturing and consuming Limestone, Dolomite and Spodumene, and all other minerals on or under the said tracts of land, and for the purpose of housing employees of Lessee, and for such purposes, and to such extent as may be necessary or convenient for accomplishing such purposes, to have the right of ingress, egress and regress over and upon the said tracts of land, the right to build and construct roads, ways, railroad tracks, pipe lines, electric power lines, telephone lines

and other structures and facilities, the right to use any waters upon the said tracts and to divert, dam and impound such waters, the right to use, remove, or demolish any buildings or structures which may be upon the FIRST TRACT, SECOND TRACT and THIRD TRACT described below and to use or dispose of the materials therein and also the right to cut down any standing timber upon said tracts and to use or dispose of such timber.

2. The tracts of land herein granted, demised, leased and let are situate in Number 4 Township, Cleveland County, North Carolina, and are more particularly described as follows, to wit:

FIRST TRACT. Both mineral and surface rights in that tract of land described as follows:

Beginning at an iron stake in the center of the old Shelby and York Road, which point of beginning is located 1330 feet N 18-26 W from a concrete monument, the eastermost corner of the 96 acre tract of land conveyed by Ephriam Jackson and wife to L. M. Williams by two deeds respectively dated 30 June 1936 and 9 November 1937, and recorded in Book 4-O page 203 and Book 4-K page 423, and runs thence with the line of Whitney Wells N 66-25 E 631.4 feet to an iron stake; thence with the line of George W. Patterson N 37-20 W 560 feet to a concrete monument, the southeastern corner of the 1.4 acre tract of land conveyed by L. S. Blalock and wife to Hunter Wells by deed dated 30 December 1918 and recorded in Book JJJ page 389; thence with the southerly line of said 1.4 acre tract S 67-56 W 448.8 feet to a concrete monument, the northermost corner of said 96 acre tract; thence with a line of said 96 acre tract S 18-26 E. 560 feet to the point of beginning, containing 6.79 acres according to plat of survey of L. B. Falls, Registered Surveyor, made in June 1949 and recorded in Plat Book 5, page 77, and being the same tract of land conveyed to L. M. Williams by deed of Whitney Wells dated 1 April 1937 and recorded in Book 4-P page 186, and being the same tract of land in which L. M. Williams and wife conveyed a one-half interest to Janie McClintock Cole, et al by deed dated 1 September 1945 and recorded in Book 5-N page 367, all of the deeds and the plat mentioned above being recorded in the office of the Register of Deeds for Cleveland County, North Carolina

SECOND TRACT. Both surface and mineral rights in that tract of land described as follows:

Beginning at a stake in the East edge of the Battle Ground Road, the Southwest corner of the 2-acre tract of land conveyed to Lizzie Mitchem by Carrie B. Hord, Executrix, by deed dated 1 August 1936 and recorded in Book 4-O page 410, and runs thence with the line of Lizzie Mitchem N 64-32 E 842 feet to an iron stake in the line of the 30 acre tract of land of Mildred L. Moss; thence with the line of Mildred L. Moss S 22-37 E 521 feet to an iron stake in the old line of the 212 acre tract conveyed by H. D. Lee and others to A. V. Falls by deed dated 15 February 1877 an recorded in Book X page 41; thence with the said line of the property formerly known as the Tin Mine land S 47-19 W 1657 feet to a sourwood on the right bank of a gulley; thence with another lin of said 212 acre tract S 26-45 W 445 feet to an iron stake; then with another line of said 212 acre tract and along the property

of George W. Patterson S 48-37 W 1379.2 feet to an iron stake, the southernmost corner of said 212 acre tract; thence with another line of said 212 acre tract and along the property of Sam Jackson and the property of Plonk N 28-46 W 2198 feet to a white oak stump; thence with another line of said 212 acre tract and along the property of Ledford N 25-42 E 889 feet to an iron stake; thence along the easterly line of the 13-1/2 acre tract of land conveyed by Carrie B. Hord, Executrix, to W. J. Crawford by deed dated 12 January 1931 and recorded in Book 4-D page 414, and along the property of Linch, Dillard and others N 11-59 E 1339 feet to the northernmost point of a large stone, a corner of said 212 acre tract; thence with a line of said 212 acre tract and along the property of Frank Glass S 49-23 E 822 feet to an iron stake, the northwest corner of the 2 acre tract conveyed by L. M. Williams and others to Will Burris and wife by deed dated 2 January 1940 and recorded in Book 4-X page 382; thence with said Burris property S 28-25 W 297 feet to an iron stake; thence with another line of said Burris property S 51-4 E 303.1 feet to an iron stake; thence with a line of the 36 acre tract conveyed by J. G. Hord and wife to J. M. Patterson by deed dated 27 November 1923 and recorded in Book NNN page 132 S 29-45 W 1024.4 feet to an iron stake; thence with another line of said Patterson property S 68-59 E 1509 feet to an iron stake on the west side of the Battle Ground Road; thence with another line of said Patterson property N 12-43 E 1003 feet to an iron stake; thence with a line of the property of Lizzie Mitchem S. 29-22 E 54 feet to the point of beginning, containing 115.23 acres according to plat of survey of L. B. Falls, Registered Surveyor, made in June 1949 and recorded in Plat Book 5, page 76, and being the same tract of land conveyed to L. M. Williams by Carrie B. Hord, Executrix, by deed dated 14 September 1936 and recorded in Book 4-Q page 3 and also being the same tract of land in which L. M. Williams and wife conveyed a one-half interest to Janie McClintock Cole, et al, by deed dated 1 September 1945 and recorded in Book 5-N page 367, all the deeds and the plat mentioned above being recorded in the office of the Register of Deeds for Cleveland County, North Carolina.

THIRD TRACT. Both surface and mineral rights in that tract of land described as follows:

Beginning at a concrete monument (formerly an ashe) east of Mill Creek and south of the School House Branch, near the mouth of School House Branch where it flows into Mill Creek, and runs thence N 10-38 E crossing School House Branch, the old York & Shelby Road and Mill Creek 345 feet to a concrete monument; thence N 18-26 W with the line of Whitney Wells, 1330 feet to an iron stake in the center of said road, the southwest corner of the 6.79 acre tract of L. M. Williams, et al; thence N 18-26 W with the westerly line of said 6.79 acre tract 560 feet to a concrete monument on the west side of said road, the northwest corner of said 6.79 acre tract; thence S 67-29 W, along the southerly line of the 10.1 acre tract conveyed by J. M. Herndon and wife to Lightal Wells by deed dated 17 February 1916 and recorded in Book BBB, page 553, 1362 feet to an iron stake; thence N 25-58 W, with another line of said 10.1 acre tract, 138 feet to a stone; thence S 51-00 W, with the property of Will Allen, 843 feet crossing a branch to an iron stake in an old stump hole; thence S 30-31 E, along the property of Will Detman, 581 feet crossing said branch three times to a maple

on the east side of said branch; thence nearly with said branch 10 courses and distances as follows: (1) S 48-56 E 197 feet to a poplar on the west side of said branch, (2) S 50-23 E 177.7 feet to an iron stake, (3) S 9-31 E 77.5 feet to a stone, (4) S 67-06 E 210 feet to a stake (formerly a spring), (5) S 36-50 E 231 feet to a large sweet gum, (6) S 21-11 E 249.3 feet to a large poplar, (7) S 3-01 E 379 feet to a stake, (8) S 12-45 E 343 feet to a stake, (9) S 63-15 E 152 feet to a stone at root of pine, and (10) S 39-00 W 132 feet crossing Mill Creek to an iron stake, a corner of the property of Ed Stewart; thence N 53-20 E, with the property of Ed Stewart, 1675 feet to the place of beginning, containing 99.8 acres according to plat of survey made by L. B. Falls, Registered Surveyor, in June 1949 and recorded in Plat Book 5, page 77, and being the same property conveyed by Ephriam Jackson and wife to L. M. Williams by two deeds dated 30 June 1936 and 9 November 1937 and recorded in Book 4-0, page 203, and Book 4K, page 423, and being the same property in which L. M. Williams and wife conveyed a one-half undivided interest to Janie McClintock Cole et al, by deed dated 1 September 1945 and recorded in Book 5N, page 367, all of the deeds and the plat mentioned above being recorded in the office of the Register of Deeds of Cleveland County, North Carolina.

FOURTH TRACT. All mining and mineral rights and all other rights, interests, easements, appurtenances and privileges defined in the four deeds recorded in Book 4-0 page 204, Book 4-0 page 206, Book 4-0 page 208 and Book 4-0 page 209 of the Cleveland County North Carolina Registry, in and to that tract of land described as follows:

Beginning at an iron stake in the west edge of a road, formerly a fallen post oak, which fallen post oak is the northeast corner of the 186 acre tract conveyed by W. W. Dickson and wife to B. O. Jenkins by deed dated 5 October 1885 and recorded in Book Q, page 491, and which fallen post oak is also a common corner of the Walker Patterson tan yard lot conveyed by John H. Crow and wife to B. O. Jenkins by deed dated 20 June 1885 and recorded in Book T, page 290, and the 182-1/2 acre tract conveyed by L. J. Dickson and wife to W. C. Graham by deed dated 21 April 1873 and recorded in Book N, page 486; and runs thence N 66-30 E 404 feet to an iron stake; thence N 35-57 W 931 ft. to an iron stake; thence N 34-57 W 967 feet to an iron stake in a line of the Will Allen land; thence S 43-59 W, crossing two roads and along a line of the Archdale Farms 1757 feet to a stake; thence S 26-39 E crossing the westerly of the two roads mentioned above, 693 feet to a stake; thence S 82-37 W 343 feet to a stake; thence S 1-41 E 577 feet to a stone; thence S 48-30 W 1386 feet to a point; thence S 34-30 E 280.5 feet to a point; thence S 49-45 E 594 feet to a stone; thence S 30-45 E 792 feet to a hickory stump; thence N 57-45 E 775 feet to a point in Mill Creek; thence S 3-00 E 957 feet to a point; thence N 81-00 E 1660 feet to a stake; thence N 6-30 W 1230 feet to a stake; thence N 51-23 E, crossing a branch, 815 feet to a stake; thence N 27-54 W, crossing a road, 240.5 ft. to a stake on the northerly side of Mill Creek; thence S 83-19 W, along the northerly side of Mill Creek, 164 feet to a stake; thence N 23-20 W 1490.6 feet to the place of beginning; containing 249.54 acres according to plat of survey of L. B. Falls, registered surveyor, made in September 1949 and recorded in Plat Book 5, page 78, and being the same land to which mineral rights therein were conveyed to L. M. Williams in 1935 by four (4) deeds recorded in Book 4-0 at pages 204, 206, 208 and 209, and being the same land to which a one-half interest in the mineral rights therein was conveyed by L. M. Williams and wife to Janie McClintock Cole, et al, by deed dated 1 September 1945 and recorded in Book 5-N, page 367, all of the deeds and the plat mentioned above being recorded in the office of the Register of Deeds for Cleveland County, North Carolina.

3. Lessee covenants and agrees to pay to Lessor a minimum rental of Two Hundred Dollars ($200.00) per month during the first year of the Lease, Three Hundred Dollars ($300.00) per month during the second, third and fourth years and Four Hundred Dollars ($400.00) per month during the fifth and succeeding years or a royalty of sixty-five cents ($.65) per ton on all Spodumene concentrates produced from the leased premises during such month, whichever is greater. The minimum monthly rental, when payable hereunder, shall be paid by Lessee on or before the last day of the month for which it is payable.

4. Lessee covenants and agrees to pay to Lessor as additional rental hereunder

(a) A royalty of seven (7%) per cent of the proceeds from the sale of all minerals or concentrates, other than Spodumene concentrates and Limestone or Dolomite, quarried, mined or produced from the leased premises. Such royalties shall accrue in the month in which the remittances for such sales are received by Lessee.

(b) Three ($.03) cents per ton on all Limestone or Dolomite quarried, mined or produced from the leased premises which is used, processed, manufactured, consumed or sold by Lessee. Such royalties shall accrue in the month in which such Limestone or Dolomite is used, manufactured or consumed by Lessee, or, if sold, during the month in which the remittances for such sales are received by Lessee. It is understood and agreed that Lessee will not sell any crushed stone derived from Limestone or Dolomite in competition with Superior Stone Company, except with said Company's written consent.

5. The royalties accruing hereunder for each month shall be paid by Lessee on or before the 15th day of the following month.

6. The word "ton" as used in this agreement shall mean 2,000 pounds, and the word "month" shall refer to a calendar month.

7. Lessee agrees that it will mill and process into Spodumene Concentrates all Spodumene bearing ore quarried, mined or produced from the leased premises which contains ten per cent (10%) or more of Spodumene, except experimental quantities resulting from

prospecting and development work.

8. This Lease shall continue and shall remain in full force and effect for the term of ninety-eight (98) years from the date hereof, unless sooner terminated as hereinafter provided.

9. In the event of the failure of Lessee to pay any rental or royalty herein provided for, or in the event of the failure of Lessee to perform any other provision of this Lease, Lessor may notify Lessee in writing of such failure, and if Lessee shall not remedy such default within a period of thirty (30) days after receipt of such written notice, Lessor shall have the right to terminate this Lease.

10. Lessee shall have the right to terminate this Lease at any time upon three (3) months notice in writing to Lessor of its intention so to do.

11. Upon the termination of this Lease either by notice as aforesaid or upon the expiration of the term hereof, Lessee shall have a period of six (6) months within which to remove from the leased premises all of the property, equipment, machinery and buildings, whether fixtures or not, which have been placed or erected by Lessee on the leased premises; Provided, however, that all rents and royalties payable hereunder up to the date of such termination have been paid in full.

12. In the event that Lessee is prevented from quarrying or mining upon the leased premises by Act of God, the public enemy, war, strikes, lockouts, (except strikes and lock-outs of Lessee's employees employed on the leased premises), riots, accidents, fire, explosion, drought, flood, action or regulation of any Governmental authority, delay in transportation, inability to obtain an adequate supply of materials or equipment, and without limiting the generality of the foregoing, any other matter or thing outside of Lessee's control, then and in any such event the minimum monthly rental specified above shall be suspended, abated and waived for such period as Lessee is so prevented from quarrying or mining upon the leased premises.

13. Lessor shall have the right during normal business hours, to inspect the books and records of Lessee which reflect or show the results of the quarrying and mining operations to be performed by Lessee upon the leased premises, for the purpose of determining the amount of the royalty payments due and to become due under the terms of this Lease. Lessor may for such purpose appoint a certified public accountant, provided such certified public accountant is satisfactory to Lessee as to the other clients of such certified public accountant.

14. The rights of either party hereunder may be assigned in whole or in part, and the provisions hereof shall extend to the heirs, executors, administrators, successors, and assigns, but no change or divisions in ownership of the leased premises, rentals or royalties, however, accomplished, shall operate to enlarge the obligations or diminish the rights of Lessee. No sale or assignment by Lessor shall be binding on Lessee until Lessee shall be furnished with a certified copy of recorded instrument evidencing same.

15. All payments of rental and royalties hereunder shall, for all purposes, be deemed to have been properly paid if payment is made in the following manner:

Payment of one-half the amount due to L. M. Williams and payment of the other one-half of said amount to Jean Cole Hatcher.

16. Lessor agrees to furnish Lessee adequate descriptions of the leased premises and such evidence of title as they possess. The investigation of the title to said lands shall be the responsibility of Lessee.

17. Lessor hereby grants to Lessee the option to purchase the surface rights to FIRST TRACT, SECOND TRACT and THIRD TRACT of the leased premises at the rate of Fifty Dollars ($50.00) per acre. Such option shall be for all or a portion of the surface of said tracts and may be exercised by Lessee from time to time and at any time during the period that this Lease remains in effect by Lessee's giving written notice of its intention to purchase all or a portion

of said surface rights to L. M. Williams, or his heirs or assigns, and to Jean Cole Hatcher, or her heirs or assigns. Upon any exercise of such option and the payment of the purchase price, Lessor shall give to Lessee a good and sufficient deed of conveyance with general warranty for the surface rights so purchased.

18. Lessee hereby grants to Lessor the option to repurchase at the rate of Fifty ($50.00) Dollars per acre any surface rights which may be purchased by the Lessee hereunder, except surface rights to land upon which permanent buildings erected by Lessee may be located, provided that the Lessor's right to exercise said option to repurchase shall arise only upon the cancellation of this Lease and shall extend only for a period of six (6) months after such cancellation. Said option to repurchase shall be exercised by Lessor's giving to Lessee written notice of Lessor's intention to repurchase said surface rights. Upon the exercise of such option and the payment of the purchase price, Lessee shall give to Lessor a good and sufficient deed of conveyance with general warranty for the surface rights so purchased.

19. The Lessor shall have the option to cancel said Lease at the end of seven (7) years from the date hereof in the event that the Lessee has not constructed permanent buildings upon the leased premises or during the last eighteen months of said seven (7) year period the Lessee has not actively carried on mining operations upon the leased premises for a total of at least six months. Said option shall be exercised by Lessor by giving written notice to Lessee within thirty (30) days from the expiration of said seven (7) years that Lessor desires to cancel the Lease.

20. In the event of cancellation of this Lease, Lessee will forward to Lessor, within thirty (30) days of such cancellation, copies of the records of all core drillings made on the leased premises by Lessee.

21. Lessee shall hold harmless Lessor from all claims for damages by persons not parties hereto by reason of the impounding of water, the construction of dams, the construction of buildings and other improvements and all other activity of Lessee connected with Lessee's use and development of the leased premises.

22. Lessee agrees that it will pay any ad valorem taxes which may accrue on the leased premises by reason of buildings or other improvements placed or constructed thereon by Lessee.

23. Lessor covenants with Lessee that they are seized of FIRST TRACT, SECOND TRACT and THIRD TRACT in fee simple and are seized of good title to the mining and mineral rights in the FOURTH TRACT, including the right of ingress and egress and the right to use water necessary for mining; that they have the right to make this lease; that the rights and interests granted to Lessee hereunder are free and clear of all encumbrances and that Lessor will warrant and defend said rights so long as this Lease shall remain lawfully in force. In the event that at any time there is any lien upon the leased premises of any character which Lessor does not promptly discharge and pay, Lessee shall have the right but shall be under no obligation to pay the same, and, in the event that it pays the same, Lessee shall become subrogated to such lien and may apply any rentals and royalties then due or thereafter accruing to the payment and satisfaction thereof.

Executed in quadruplicate.

EXHIBIT 3. (d)

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

IN WHITNESS WHEREOF, Lessor has hereunto set their hands and seals, and Lessee has caused its corporate seal to be hereunto affixed, duly attested by its proper officers upon the date first above written.

SS/ L. M. Williams (SEAL)
L. M. Williams

SS/ Lena B. Williams (SEAL)
Lena B. Williams
JANIE McCLINTOCK COLE

By SS/Jean Cole Hatcher (SEAL)
Attorney in Fact, Jean Cole Hatcher

SS/ Jean Cole Hatcher (SEAL)
Jean Cole Hatcher

SS/ Rube Hatcher (SEAL)
Rube Hatcher

SS/ Emily Cole Hovis (SEAL)
Emily Cole Hovis

SS/ Robert A. Hovis (SEAL)
Robert A. Hovis

SS/ Frances Cole Culp (SEAL)
Frances Cole Culp

SS/ B. B. Culp (SEAL)
B. B. Culp

FOOTE MINERAL COMPANY

By SS/ H. C. Meyer (SEAL)
President

ATTEST:

SS/ Ernest G. Enck
Secretary

EXHIBIT 3. (d)

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

NORTH CAROLINA
MECKLENBURG COUNTY

I, Hazel S. Franks Notary Public for said County and State, do hereby certify that L. M. Williams and wife, Lena B. Williams, personally appeared before me this day and acknowledged the due execution of the foregoing Lease;

WITNESS my hand and Notarial seal, this 14th day of December, 1949.

SS/ Hazel S. Franks
Notary Public

My commission expires: February 9th, 1951

NORTH CAROLINA
MECKLENBURG COUNTY

I, Frances B. McMillan Notary Public for said State, do hereby certify that Jean Cole Hatcher, Attorney-in-fact for Jamie McClintock Cole (widow), Jean Cole Hatcher and husband, Hube Hatcher, Emily Cole Hovis and husband, Robert A. Hovis, personally appeared before me this day and acknowledged the due execution of the foregoing Lease;

WITNESS my hand and Notarial seal, this 12th day of December, 1949.

SS/ Frances B. McMillan
Notary Public

My commission expires: 11-3-50

NORTH CAROLINA
GASTON COUNTY

I, Pauline S. Scruggs Notary Public for said County and State, do hereby certify that Frances Cole Culp and husband, B. B. Culp, personally appeared before me this day and acknowledged the due execution of the foregoing Lease;

WITNESS my hand and Notarial seal, this 10th day of December, 1949.

SS/ Pauline S. Scruggs
Notary Public

My commission expires: March 3, 1950

COMMONWEALTH OF PENNSYLVANIA
PHILADELPHIA COUNTY

This 20th day of December, A.D. 1949, personally came before me, H. C. Meyer, who, being by me duly sworn, says that he is the President of Foote Mineral Company and that the seal affixed to the foregoing Lease in writing is the corporate seal of the Company, and that said writing was signed and sealed by him in behalf of said Corporation, by its authority duly given. And the said H. C. Meyer acknowledged the said writing to be the act and deed of said Corporation.

SS/ Frank E. Zelaney
Notary Public

My commission expires at end of
next Session of Senate

EXHIBIT 3. (d)

Foote Mineral Company,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

NORTH CAROLINA

MECKLENBURG COUNTY

INDEMNITY AGREEMENT

L. M. Williams and wife, Lena B. Williams, Janie McClintock Cole (widow) by her Attorney-in-fact, Jean Cole Hatcher (see power of attorney recorded in Book 5Q, page 640, of the Cleveland County Registry), Jean Cole Hatcher and husband, Bube Hatcher, Emily Cole Hovis and husband, Robert A. Hovis, all of Mecklenburg County, North Carolina, and Frances Cole Culp and husband, B. B. Culp, of Gaston County, North Carolina, hereinafter collectively called "Lessor", for and in consideration of the execution by Foote Mineral Company, hereinafter called "Lessee", of a lease by and between Lessor and Lessee of certain property situated in No. 4 Township, Cleveland County, North Carolina, which property is fully described in said lease and shown on plats recorded in Plat Book 5, pages 76, 77 and 78 of the Cleveland County Registry, which lease is of even date and is executed contemporaneously herewith, and in further consideration of the payment by Lessee to Lessor of the sum of One Dollar ($1.00), receipt of which is hereby acknowledged, Lessor does hereby undertake and agree as follows:

1. Lessor, their heirs, personal representatives and assigns, will indemnify and hold harmless Lessee from any and all loss which Lessee may at any time hereafter suffer or sustain by reason of Lessee's exercise of any of the rights and privileges granted to Lessee by said lease, which loss may be caused by or attributable to any lack of a fee simple indefeasible title in Lessor to any part of the FIRST TRACT, SECOND TRACT and THIRD TRACT described in said lease.

2. Lessor, their heirs, personal representatives and assigns, will defend at their own expense any and all actions at law, whether groundless or not, which may be brought against Lessor or Lessee or both of them, while said lease is in force, by any person or persons claiming or asserting any title to or right to

possession of any part of said FIRST TRACT, SECOND TRACT or THIRD TRACT described in said lease and, if Lessor does not undertake to properly defend any such action promptly after same is brought, Lessee shall have the option to undertake such defense, but shall not be obligated to do so, and in the event Lessee does undertake such defense Lessor will pay the reasonable cost of said defense to Lessee and said cost shall be a charge against any rent or royalties then or thereafter due by Lessee to Lessor under said lease and Lessee may deduct such charges from said rents and royalties until such charges are fully paid.

IN WITNESS WHEREOF, Lessor has hereunto set their hands and seals this 10th day of December, 1949.

Witness as to L. M. Williams and Lena B. Williams:

SS/ Helena W. Dudley

SS/ L. M. Williams (SEAL)
L. M. Williams

SS/ Lena B. Williams (SEAL)
Lena B. Williams

JANIE McCLINTOCK COLE

Witness as to Jean Cole Hatcher, Attorney-in-Fact, Jean Cole Hatcher, Rube Hatcher, Emily Cole Hovis and Robert A. Hovis:

SS/ Frances B. McMillan

by SS/Jean Cole Hatcher (SEAL)
Attorney-in-Fact, Jean Cole Hatcher

SS/ Jean Cole Hatcher (SEAL)
Jean Cole Hatcher

SS/ Rube Hatcher (SEAL)
Rube Hatcher

SS/ Emily Cole Hovis (SEAL)
Emily Cole Hovis

SS/ Robert A. Hovis (SEAL)
Robert A. Hovis

Witness as to Frances Cole Culp and B. B. Culp:

SS/ Pauline S. Scruggs

SS/ Frances Cole Culp (SEAL)
Frances Cole Culp

SS/ B. B. Culp (SEAL)
B. B. Culp

C O P Y

EXHIBIT 4. (b)-2
- 1 -

Foote Mineral Company,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

April 3, 1951

Mr. Gordon Chambers,
Foote Mineral Company,
18 West Chelten Avenue,
Philadelphia 44, Pa.

Dear Mr. Chambers:

We have received the Affidavit and Request for Factual Data completed by your company with respect to properties near Kings Mountain, North Carolina. We are, therefore, enclosing Trace Elements Memorandum Report 250, by W. R. Griffitts, entitled "Beryllium Content of Spodumene-Bearing Pegmatites on the Solvay Process Company's property near Kings Mountain, North Carolina." This report gives the available factual data on beryllium content and mineral composition of pegmatites within the area specified in the affidavit. It was prepared in response to a request by Mr. Robert D. Nininger of the Atomic Energy Commission in January that the factual data be made available to you.

I trust that the information will be useful to you.

Sincerely yours,

(Signed) W. H. Bradley
Chief Geologist

Enclosure

C O P Y

EXHIBIT 4. (b)-2
- 2 -

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

Beryllium content of spodumene-bearing pegmatites on the Solvay Process Company's property near Kings Mountain County, North Carolina

February 1951

Wallace R. Griffitts

Pegmatite was sampled at eight localities on the property south of Kings Mountain, N. C., owned by the Solvay Process Company and leased by the Foote Mineral Company. The sampling was done in the winter and summer of 1949 by W. R. Griffitts with the assistance of R. E. Burns. All the samples were analysed spectrographically for BeO, and visual estimates were made of the mineral proportions.

The table summarizes the mineralogic data as well as the determined BeO values. Mill tailings, and spodumene, feldspar and mica concentrates were also sampled. The percent BeO in the tailings ranges from 0.013 to 0.073; the average is 0.036 percent BeO. The tailings pond contains about 27,000 yards of sand. The spodumene, feldspar, and mica concentrates contain 0.074, 0.058, and 0.015 percent BeO respectively. The mill feed contains 0.053 percent BeO.

Beryl was found in a few places in crystals 1/8 to 1 inch across. Whether or not other beryllium minerals are present is not known. Most of the beryl is white, although some is very pale green. The pale color and the occurrence in fine-grained feldspathic rocks makes the mineral obscure. Brief petrographic examination of beryllium-bearing aplite showed that beryl occurs in grains only a small fraction of a millimeter in breadth. Optical determinations indicated that beryl from Solvay Dike 21 contains 12.3 percent BeO.

The plagioclase is largely sodic albite, which occurs in grains smaller than an eighth of an inch. Most of the quartz also occurs on small grains, but they may be clustered together to make lumps several inches across. Muscovite flakes rarely exceed half an inch in diameter. The average grain size of the spodumene is indicated in the table.

C O P Y

Beryllia content and mineral composition of samples from pegmatites on the Solvay Process Company's property near Kings Mountain, North Carolina

Locality	Sample No.	Length (inches)	BeO (percent)	Mineral composition in percent: Spodumene	Microcline	Plagioclase	Quartz	Muscovite	Spodumene grain size (inches)
NE	1	6	0.044	-	-	80?	20?	-	-
	2	20	0.034	25	15	40	20	-	4
	3	20	0.062	10	-	0?	80?	-	1
	4	8	0.055	-	-	0?	100?	-	-
	5	23	0.050	30	-	-	-	-	3
	6	40	0.030	30	10	0?	60?	-	5
	7	10	0.055	15	10	0?	75?	-	4
	8	120	0.025	15	15	55	25	-	3
	10	6	0.033	-	-	80?	20?	-	-
NW	1	15	0.015	-	-	75?	25?		
	2	17	0.061		50	15?	35?		2
	3	46	0.036			80	20		
	4	63	0.033	15	20	35?	30?		2
	5	150	0.018	15	5	60?	20?		3
	6	216	0.025	15	5	60?	20?		3
E	1	8	0.036			70	30		
	2	16	0.055			68	30	2	
	3	25	0.043	20	15		65		3
	4	15	0.067						
	5	18	0.042	40					4
	6		0.017			80	20		
KM3	1	8	0.067	25	20	30	25		1
	2	90	0.043	20	25	20	30	5	3
	3	7	0.046	20	20	20	25	15	5
	4	9	0.071	25	15	20	25	15	4
	5	7	0.051	10	40	30	10	10	3
	6	15	0.052	30	40	10	20		4

EXHIBIT 4. (b)-2

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

Locality	Sample No.	Length (inches)	BeO (percent)	Mineral composition in percent					Spodumene grain size (inches)
				Spodumene	Microcline	Plagioclase	Quartz	Muscovite	
KM 1	1	10	0.056	10	?	45?	35	10	0.5
	2	4	0.12	5	?	60?	30	5	0.1
	3	7	0.12			65	30	5	
	4	13	0.034	10	15	50	25		1

EXHIBIT 4. (b)-2

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

Beryllia content and mineral composition of samples from pegmatites on the Solvay Process Company's property near Kings Mountain, North Carolina (cont.)

Locality	Sample No.	Length (inches)	BeO (percent)	Mineral composition in percent: Spodumene	Microcline	Plagioclase	Quartz	Muscovite	Spodumene grain size (inches)
KM2	1	7	0.084	30	5	35	30		4
	2	10	0.078	30	5	35	30		5
	3	13	0.064	25	10	45	20		5
	4	14	0.050	30	35	18	10	2	4
	5	12	0.052	25	30	28	10	2	3
	6	14	0.062	10	10	60	20		2
	7	16	0.034	30	18	27	20	5	5
	8	20	0.060	20	60		20		2
KM 7	1	20	0.027	30	10	38	20	2	4
	2	55	0.046	5	30	43	20	2	3
	3	23	0.064	20	20	35	22	3	6
	4	17	0.046	20	20	35	23	2	4
	5	19	0.058	20	25	30	23	2	
KM8	1	175	0.035	20	20	40	15	5	5

Index to localities

NE. Northeast corner of Solvay quarry.
NW. Northwest corner of Solvay Quarry.
E. Dike exposed in ramp leading to Solvay quarry.
KM1. 600 feet N. 70°W. of Solvay quarry, north of road.
KM2. 600 feet S. 50°W. of Solvay quarry, near south end of company pegmatite No. 21.
KM3. South end of quarry in company pegmatite No. 21.
KM7. Company pegmatite No. 8, at church.
KM8. North end of dike 600 feet N. 55° E. of church.

EXHIBIT 4. (b)-2
- 5 -

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

EXHIBIT 4. (c)-2

C O P Y

Foote Mineral Co.
18 W. Chelten Ave.,
Philadelphia 44, Pa.

Richard M. Foose,
Consulting Geologist
Rohrerstown, Penna.

January 11, 1952

Mr. Felix Shay, Vice President,
Foote Mineral Company,
Kings Mountain, North Carolina

Dear Felix:

If I live through this month I guess I'll last for awhile. Everything has piled up at one time with the ending of our first semester. I had of course completed a good deal of the work needed for spotting holes, but not nearly all that was needed by the time of your phone call early this week. Therefore, please consider these hole locations as tentative, and the depths indicated as estimates which approximate the order of magnitude. Actually, I think the holes as spotted here would thoroughly round out the picture for a long time to come.

1. Drill all the inclined holes: a. 75 degrees E. of Plant N.
   b. 50 degrees to horizontal.

2. The most important holes are marked with an asterisk in the Table and in red on the map. These should be drilled first and they would actually suffice for the development of the deposit for a long time into the future.

3. The footage indicated is the order of magnitude to be expected. Actual termination of each hole should be contingent upon logging of the core.

4. Some of the locations are tentative and may be changed or eliminated on the basis of the more detailed work which is currently being done.

Grid Location	Hole	Estimated length of hole (fe
	Northeastern Area	
1350-7300	Vertical	300
1450-7000	Inclined	400
1600-6900	Vertical	300
1800-6500	*Vertical	300
1700-6300	*Vertical	300-400
1900-6300	*Vertical	300
1850-6100	*Vertical	300
1900-5900	Vertical	300
2000-6000	*Inclined	400
2100-5900	Vertical	300
2200-6200	Vertical	200
2200-6400	*Vertical	300

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

Grid Location	Hole	Estimated length of Hole (feet)
	Northeastern Area (cont.)	
2000-6300	*Inclined	250
2000-6500	*Inclined	400-450
2000-6700	Inclined	400
2200-6800	Vertical	250-300
2150-7000	Vertical	250-300

Total estimated footage on 8 most important holes is 2700 feet.

	Central Area	
2000-5700	Inclined	350
2000-5500	Inclined	350
2000-5200	Inclined	400
1800-5100	Vertical	200
1600-4900	*Inclined	350
1500-5100	*Vertical	200-250
1500-5300	Vertical	150-200
1400-5500	*Vertical	300-400

Total estimated footage on 3 most important holes is 1000 feet.

	Southwestern Area	
1800-3850	*Vertical	250
1800-4000	*Inclined	400
1700-4200	*Vertical	300
2100-4100	Vertical	200
2100-4400	Vertical	200

Total estimated footage on 3 most important holes is 950 feet.

The fact that all drill cores have been destroyed from the Solvay Process Corp. drilling in 1943 makes it all the more important that an effective drilling program be implemented in the near future. Not only is it necessary for effective planning of mining operations, but also for the examination and the testing of actual pegmatite especially with regard to the important minerals occurring in small quantities, like cassiterite, columbite, and beryl.

I agree with you that the areas to the southwest of the main property should be mapped in the near future and should be included in general considerations of an over-all exploration program, such as the proposed diamond drilling.

With best regards.

Sincerely yours,

s/ Pete

Richard M. Foose

EXHIBIT 5. (d)-1

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

F. B. SHAY
Vice President in Charge of Production of Foote Mineral Co.

Mr. Shay is a Canadian by birth, a graduate of Staunton Military Academy, and received his B.S. in Mining from Lehigh University in 1931. Starting with three years in the Andes at Braden Copper, Chile, learning large scale mining, Shay applied his knowledge to small scale mining first in North Carolina, and then for the Agua Fria Mining Company in Honduras, as chief engineer.

Mr. Shay then spent a year as production engineer with the United Color and Pigment Company, now a division of American Cyanamid Company. He joined Foote Mineral Company in 1940 as manager of the grinding plants, and later became production manager, supervising production and engineering. In 1951 he became Vice President in Charge of Production.

He is the author of a number of technical articles and has made mining trips for the Company to Cuba, Mexico, Canada and various parts of the United States.

EXHIBIT 5. (d)-2

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

DUDLEY L. RAINEY

Dudley L. Rainey has recently joined the Foote Mineral Company as Mining Engineer of the Company's Kings Mountain, North Carolina branch.

Mr. Rainey is a graduate of the Colorado School of Mines. Prior to his joining the Foote staff he was associated with Columbia University as Research Assistant doing research in mining methods. Mr. Rainey is a member of the American Institute of Mining and Metallurgical Engineers. He has been with Foote Mineral Company about one year.

MINING WORLD

in this issue

Tin Mining in the Congo

Page 32

TEN YEARS SERVICE

This Eimco Model 21 worked ten consecutive full years before removed from mine for overhaul. Total cost new parts for overhaul $21.16.

EIMCO

A406

THE EIMCO CORPORATION

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IN ENGLAND EIMCO (GREAT BRITAIN) LTD LEEDS 12, ENGLAND
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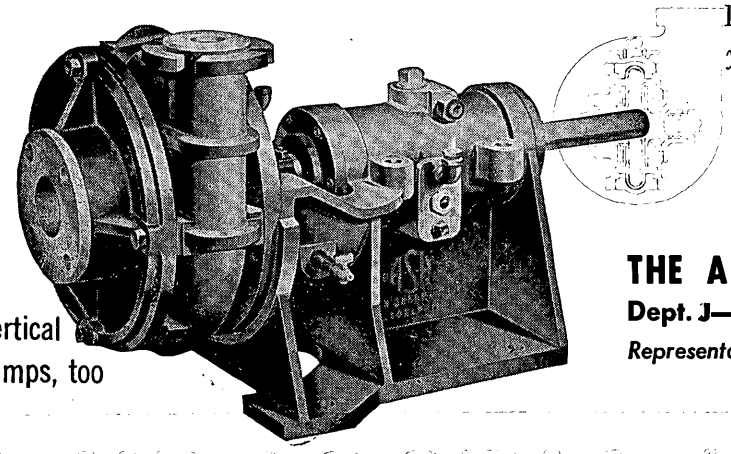
NOVEMBER, 1952

Vol. 14 No. 12

35 cents a copy
In sterling 3s

How we know what Hydroseals will do for you

Engineering and guesswork don't get along very well together—at least, not for long. To keep guesswork out of Hydroseal engineering, we've kept complete performance records on almost every pump we've sold. These records contain a description of the pump, its operating conditions, power requirements and all repair parts ordered. Naturally, almost every conceivable pumping condition is included, and the biographies cover a span of years. In most cases, users have found that Hydroseals have paid for themselves in less than a year in power savings alone, with lowered maintenance costs an additional bonus. If you'd like to know what a Hydroseal will do under *your* specific conditions, write us.



Vertical pumps, too

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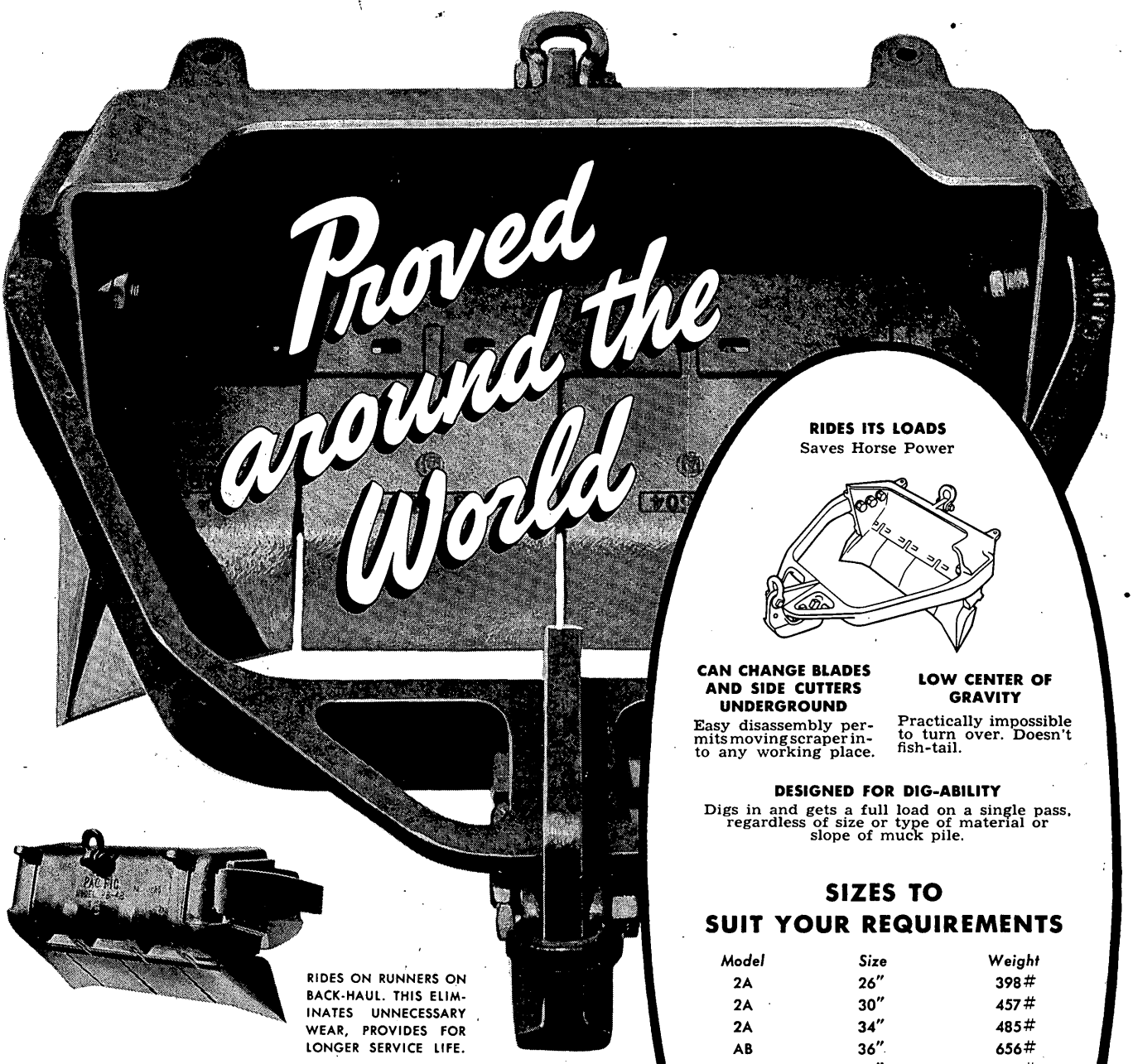
THE ALLEN-SHERMAN-HOFF PUMP CO.
Dept. J—259 E. Lancaster Ave., Wynnewood, Pa.
Representatives throughout the World

HYDROSEAL SAND, SLURRY & DREDGE PUMPS
MAXIMIX RUBBER PROTECTED

HYDROSEAL, PACKLESS AND MAXIMIX DESIGNS ARE COVERED BY PATENTS AND APPLICATIONS IN THE MAJOR MINING CENTERS OF THE WORLD



RIDES ON RUNNERS ON BACK-HAUL. THIS ELIMINATES UNNECESSARY WEAR, PROVIDES FOR LONGER SERVICE LIFE.

RIDES ITS LOADS
Saves Horse Power

CAN CHANGE BLADES AND SIDE CUTTERS UNDERGROUND
Easy disassembly permits moving scraper into any working place.

LOW CENTER OF GRAVITY
Practically impossible to turn over. Doesn't fish-tail.

DESIGNED FOR DIG-ABILITY
Digs in and gets a full load on a single pass, regardless of size or type of material or slope of muck pile.

SIZES TO SUIT YOUR REQUIREMENTS

Model	*Size*	*Weight*
2A	26"	398#
2A	30"	457#
2A	34"	485#
AB	36"	656#
AB	42"	698#
2B	36"	1240#
2B	42"	1346#
2B	48"	1432#
2C	60"	2275#

Pacific "Slushmaster" Scrapers are proving their dig-ability and stand-up-ability under almost every conceivable condition in all parts of the world—in the Philippines, Africa, South America, Mexico, the U.S.A. and Canada. The acceptance of these scrapers by mining companies everywhere is due to their design superiority.

They dig in, secure a full load in a single pass and then carry it with less horsepower. Here are typical quotes from satisfied customers: "Best breast cleaning scraper ever designed,"..."It's the 'slushingest' bucket I've ever seen,"..."You have to see 'em work to believe it." Send for Bulletin No. 215 for complete information.

BE SPECIFIC—ORDER PACIFIC. For added efficiency, use Pacific Sheave Blocks, Sheave Anchors, "Round-The-Corner" Sheave Blocks, Jaw Crushers, Bit Knockers and Pacific Wearing Parts.

ALLOY STEEL & METALS CO.

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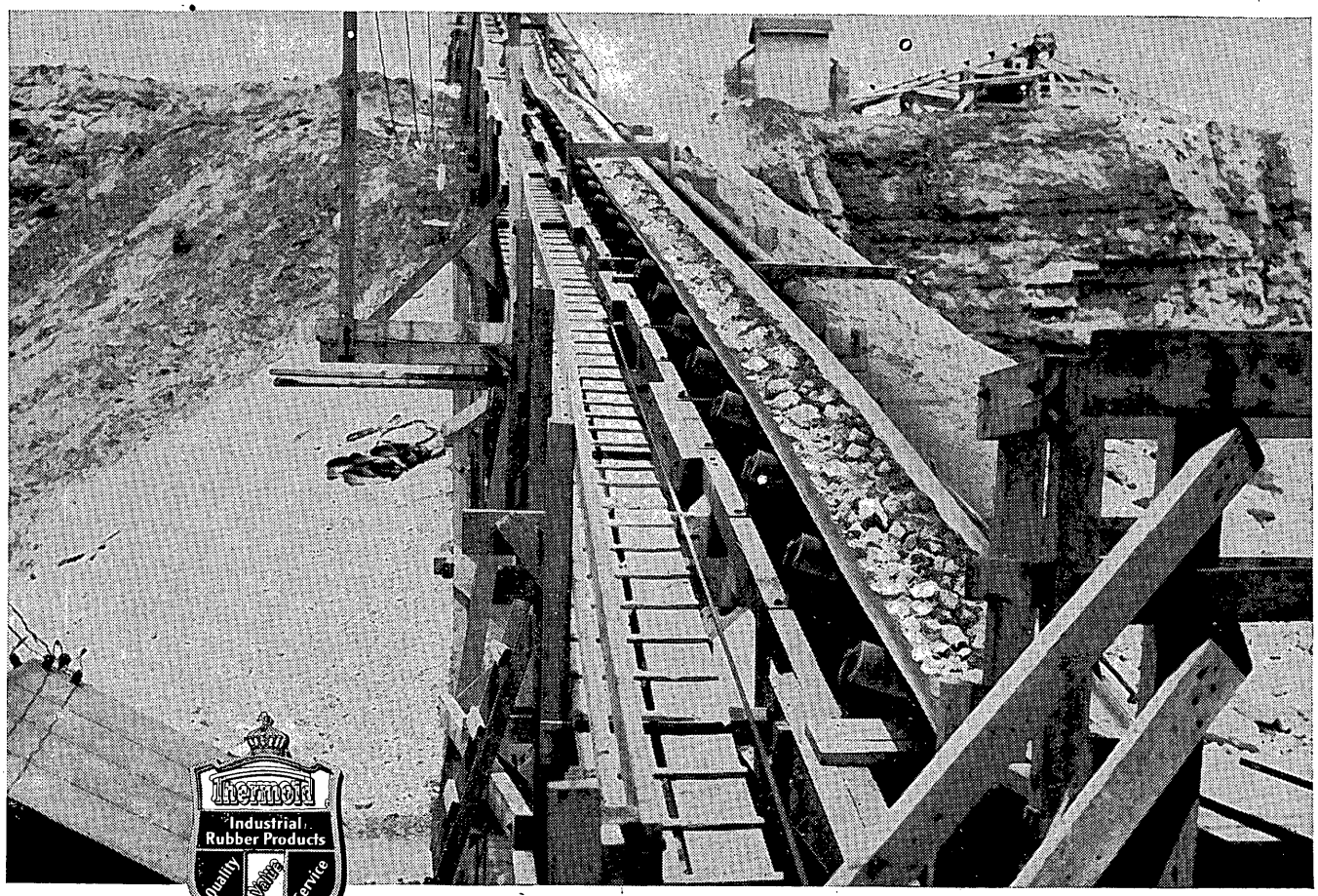
ALLOY STEEL & METALS CO., 1848 East 55th Street, Los Angeles 58, California
(Mailing address: Box 15323 Vernon Station, Los Angeles 58, California)



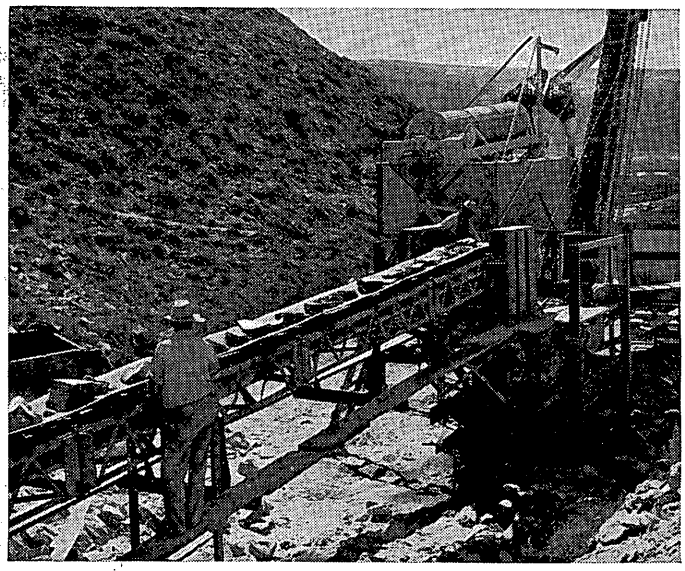
Nothing too rough or tough for Thermoid Conveyor Belting

Thermoid's long experience and continuing research *in the field*, pays off with real economy, maximum efficiency and greater tonnage for your belting dollar. Regardless of the size or kind of material—light or heavy, soft or abrasive, hot or cold, wet or dry—whatever the job, it's a good bet that Thermoid has solved the same or a similar problem with a belt that will do the job better.

In most cases, your Thermoid distributor can select the belt that will serve your needs most economically. Where unusual conditions exist, he will call in an experienced Thermoid Sales Engineer.

Get in touch with your Thermoid distributor or write direct for a copy of the Thermoid Conveyor Belting Catalog No. 3679.

It will pay you to specify Thermoid



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Offices and Factories: Trenton, N.J. Nephi, Utah

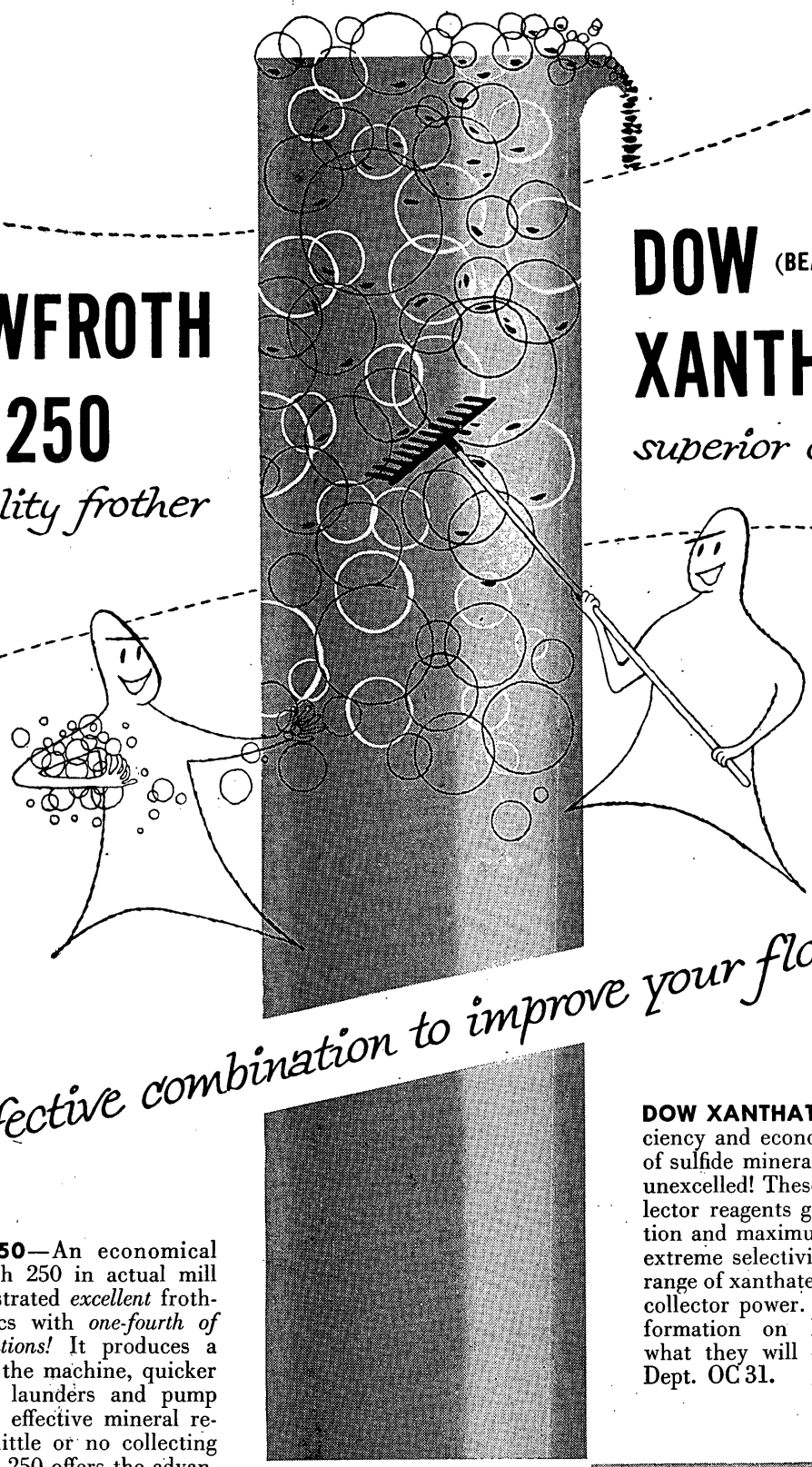
MINING WORLD, November, 1952. Volume 14 No. 12. Published monthly, except April when publication is semi-monthly, at Emmett St., Bristol, Conn. Executive, advertising and editorial offices, 121 Second St., San Francisco 5, California. Subscription in United States, North Central and South America, $3.00 per year; other countries, $4.00 per year. Entered as second class matter Oct. 10, 1951 at the Post Office at Bristol, Conn., under the act of March 3, 1879. Postmaster: please send notice 3579 to MINING WORLD, 71 Columbia St., Seattle 4, Washington.

DOWFROTH 250

a quality frother

DOW (BEAR BRAND) XANTHATES

superior collectors



an effective combination to improve your flotation!

DOWFROTH 250—An economical frother, Dowfroth 250 in actual mill tests has demonstrated *excellent* frothing characteristics with *one-fourth of normal concentrations!* It produces a livelier froth on the machine, quicker breaking in the launders and pump boxes, and more effective mineral recovery. Having little or no collecting power, Dowfroth 250 offers the advantage of independent regulation of frother and collector for good control. Try Dowfroth 250—write to Dept. OC 31 for your *free* mill-test sample!

DOW XANTHATES—For greatest efficiency and economy in the separation of sulfide minerals, Dow xanthates are unexcelled! These uniform quality collector reagents give greater concentration and maximum recovery. To allow extreme selectivity, Dow offers a wide range of xanthates—all possessing good collector power. For more detailed information on Dow xanthates and what they will do for you, write to Dept. OC 31.

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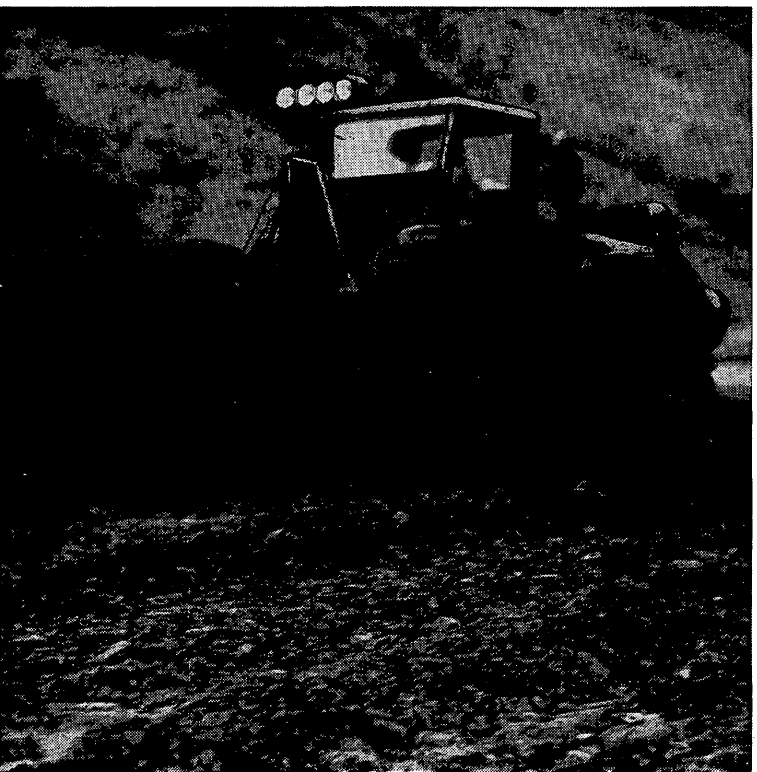
CHEMICALS
INDISPENSABLE TO INDUSTRY AND AGRICULTURE

"CONSOLIDATION COAL"

...with 2 rubber-tired Tournadozers

Consolidation Coal Company, (Ky.), a division of Pittsburgh Consolidation Coal Company, operates 4 mines and 2 preparation plants within a 20-mile radius of their offices at Jenkins, Kentucky. One of their 2 rubber-tired C Tournadozers handles all clean-up work at their "Beefhide" spread . . . the second "C" is on standby duty to handle emergency jobs at *all four* mines and the Jenkins Preparation Plant. This rubber-tired unit drives to the scattered job locations under its own power . . . travels over paved highways, limestone and red-dog surfaced mine roads, across tracks, up and down 20% grades at speeds up to 19 m.p.h. It is ready to go *anywhere* at a moment's notice. No blocking, loading or unloading delays at any time! With high speeds on rubber, it puts spare time to work . . . drains refuse areas . . . strips overburden . . . hauls equipment on low-bed trailers . . . handles many other odd jobs.



Saves 1" to 2" of coal on clean-up work

On clean-up assignments, Tournadozer's low-pressure tires reduce coal waste . . . don't dig coal into the ground or grind it into unrecoverable fines. At the "Beefhide" mine, for example, Consolidation's Tournadozer saves an estimated 1" to 2" of coal on its continuous cleaning operation.

Mobile Tournadozer gives "Consolidation" important *mechanical* advantages, too! 186 h.p. engine and 4-wheel drive put plenty of power behind the rugged 2½-yard blade. Instant-shift selection of 4 forward speeds saves vital momentum . . . lets operator drift loads in higher gears. Reverse speeds to 8 m.p.h. cut non-productive time on return half of cycle for more passes per hour. Big 21.00 x 25 low-pressure tires give plenty of sure-footed traction in soft material. Powerful 4-wheel, disc-type air brakes assure fast, safe control at all times.

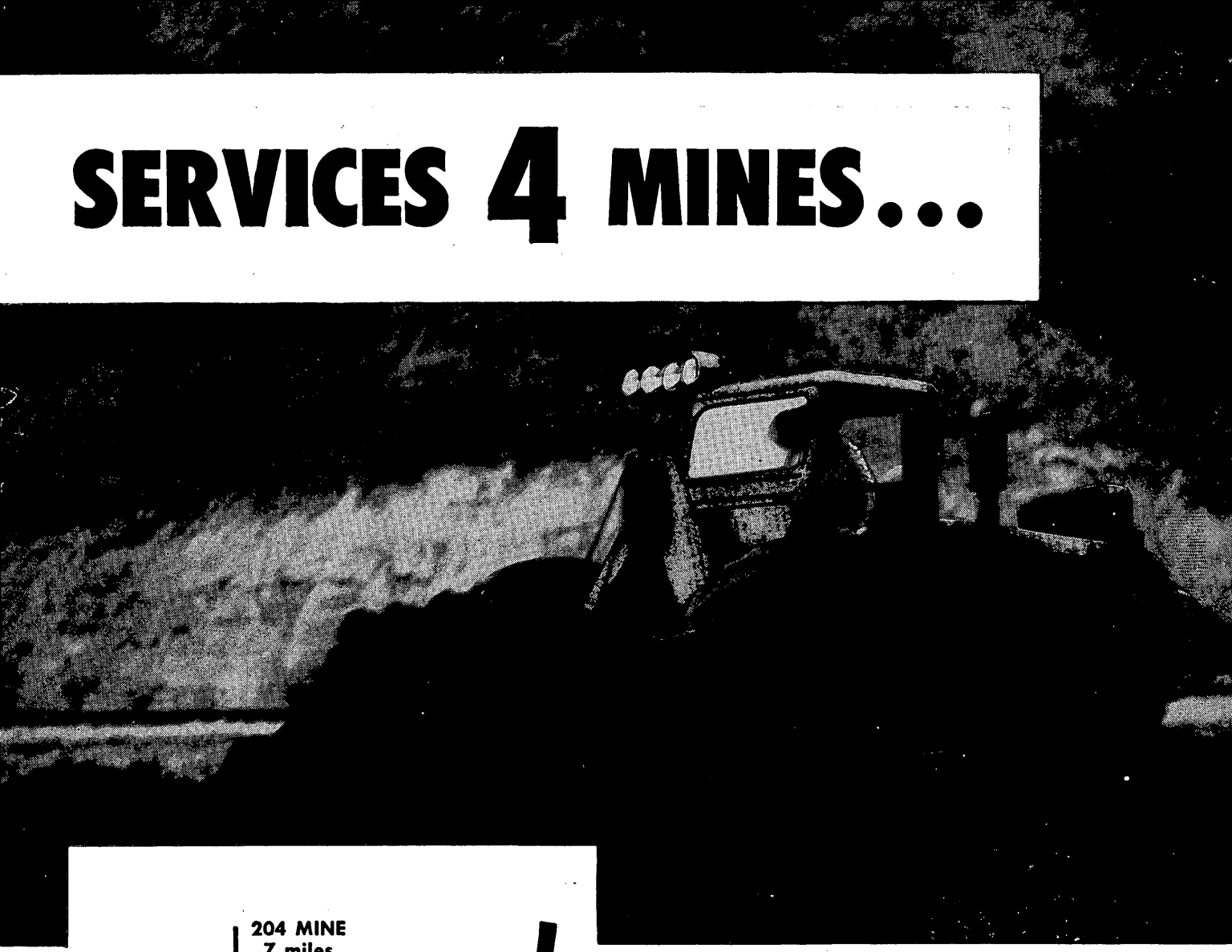
Your LeTourneau Distributor will be glad to show you the Tournadozer in action, so you can judge these advantages for yourself. Call him next time you're considering dozers.

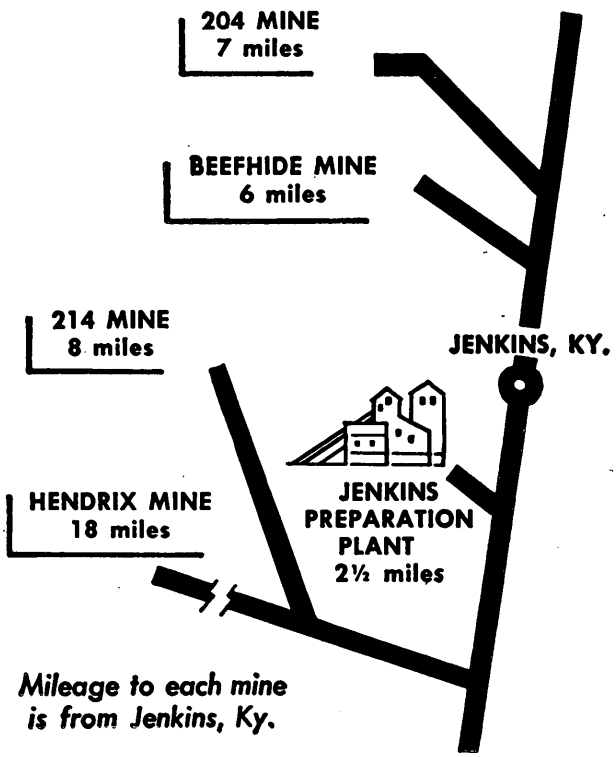
Tournadozer—Trademark Reg. U. S. Pat. Off. D-32-CM

R. G. LeTOURNEAU, INC.
Peoria, Illinois

HIGH-SPEED, RUBBER-TIRED EXCAVATING

SERVICES 4 MINES...





Mileage to each mine is from Jenkins, Ky.

At the Hendrix mine slate dump, Tournadozer pushes its load of truck-dumped slate 75′ in 2nd gear (3.7 m.p.h.) . . . returns to dumping point in high reverse (8 m.p.h.).

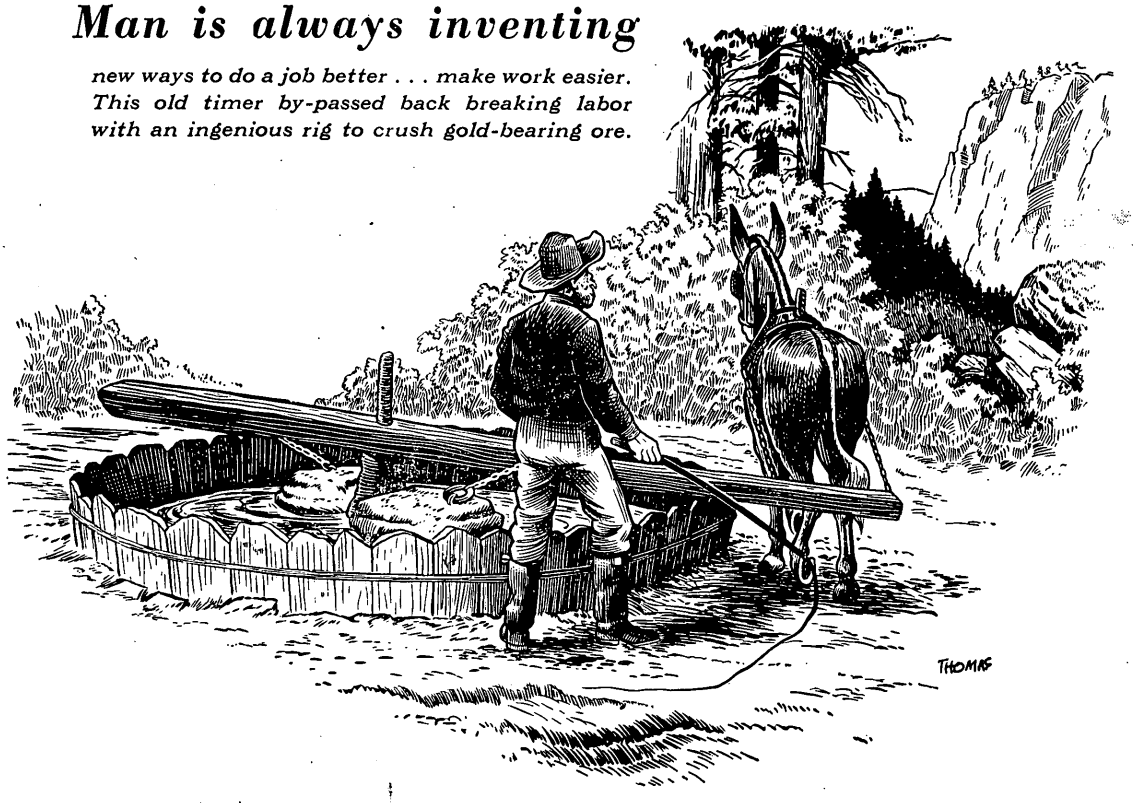
Tournadozer works on loose spoil banks or hard-packed coal seams without damaging coal surface . . . completes dozing cycles in ½ to ⅓ the time required by crawler-tractors.

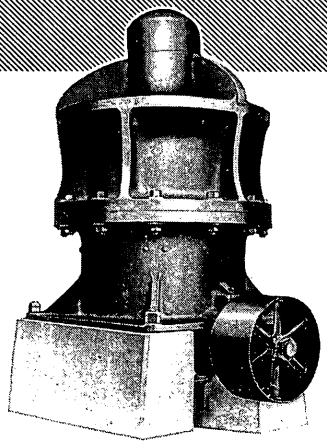
HAULING • LIFTING EQUIPMENT

LeTourneau LET Equipment

Man is always inventing

new ways to do a job better . . . make work easier. This old timer by-passed back breaking labor with an ingenious rig to crush gold-bearing ore.





The Traylor TY Reduction Crusher incorporates maximum efficiency with easy maintenance for top performance on the job. Ask for Bulletin 6112 for complete details.

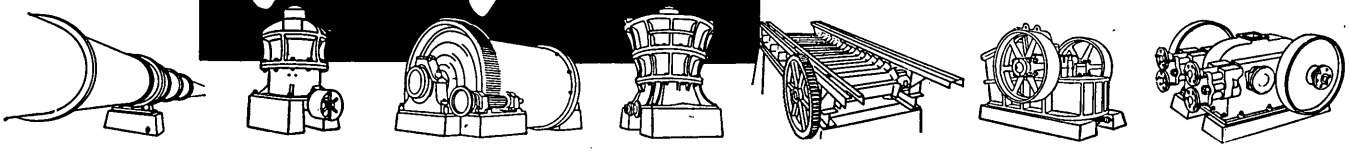
The mining industry is famous for its ingenuity in finding ways to speed production while obtaining a better product. For 50 years, Traylor has fostered this ability by constantly improving crushing machinery. As in the past, so in the future, each year brings new methods—and new problems—to the industry. Mining men know that experience is their best source for solving these problems. Traylor has experience . . . half a century of it.

OUR GOLDEN ANNIVERSARY YEAR

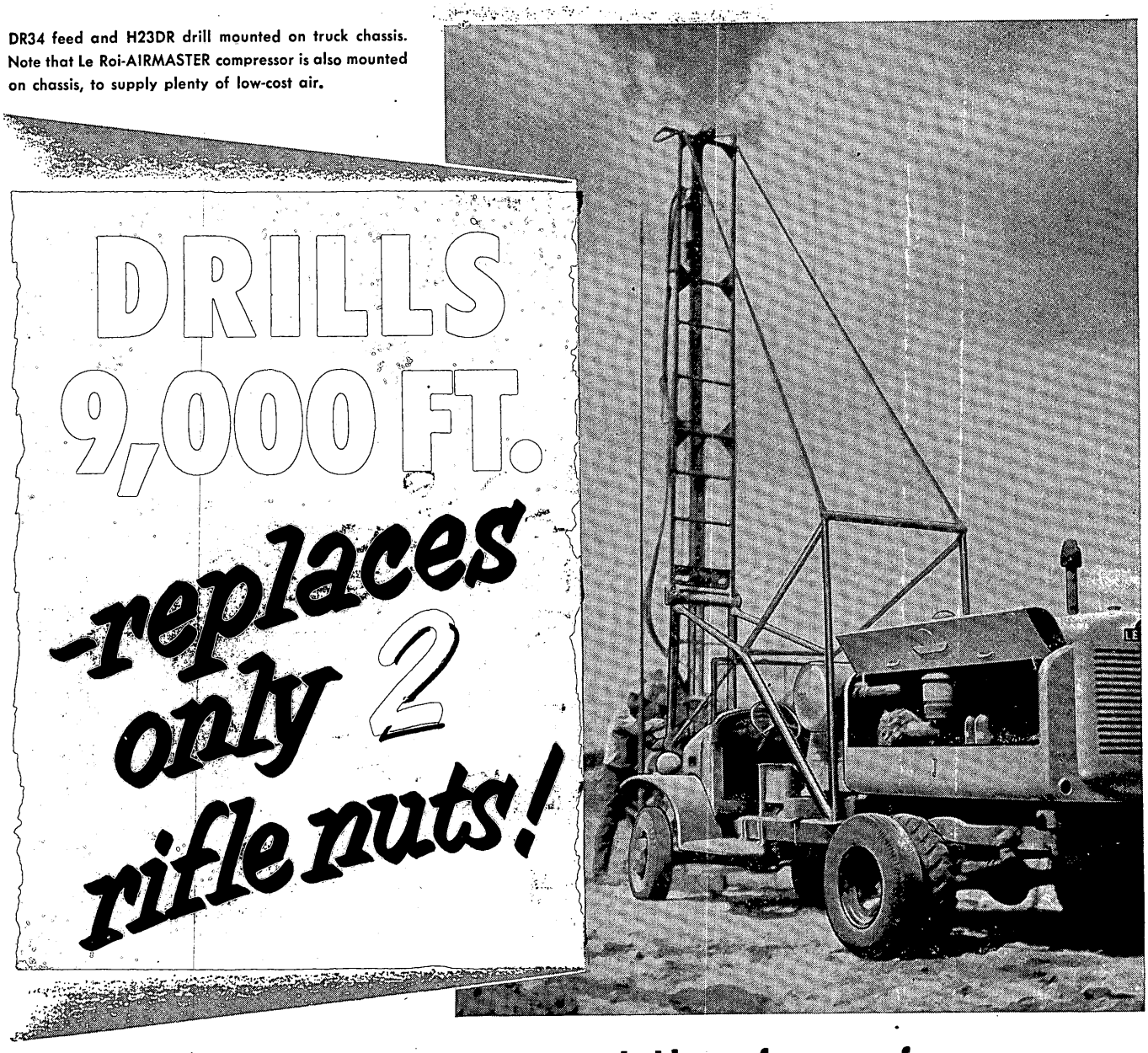
1902 1952

TRAYLOR ENGINEERING & MANUFACTURING CO.
1483 MILL ST., ALLENTOWN, PA.
SALES OFFICES: New York, Chicago, San Francisco
Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P. Q.

a **Traylor** *leads to greater profits*



DR34 feed and H23DR drill mounted on truck chassis. Note that Le Roi-AIRMASTER compressor is also mounted on chassis, to supply plenty of low-cost air.



Uranium operation gets remarkable performance from LE ROI-CLEVELAND AIR FEED and H23DR DRILL

HOLES as deep as 120 feet drilled with sufficient air for hole cleaning! 18 feet of hole in 12 to 14 minutes, with 90 to 95 psi air pressure. Mister, that's real drilling! And it's typical of the money-making performance you get with Le Roi-CLEVELAND rock drills.

The DR34 air-feed shell provides a 21′ feed with 20′ steel change. The drill is a Le Roi-CLEVELAND 80-lb. H23DR with 5/16″ blowing, strong rotation, positive valve action, plenty of wallop, and dependable durability. Chuck size is standard — 1″ hex, 4-1/4″ shank. Octagon or round-lug shanks can be used, also.

Though 120′ holes have been sunk in uranium-prospect drilling operations — using jointed steels and standard forged steel-type detachable bits with stellited corners — average drilling depth with the DR34 for blast holes is 40′ to 50′, depending on the contour of the terrain.

On deep-hole work, enjoy more footage per shift — do your drilling better, faster, for less — with Le Roi-CLEVELAND machines.

Write today for complete information.

LE ROI

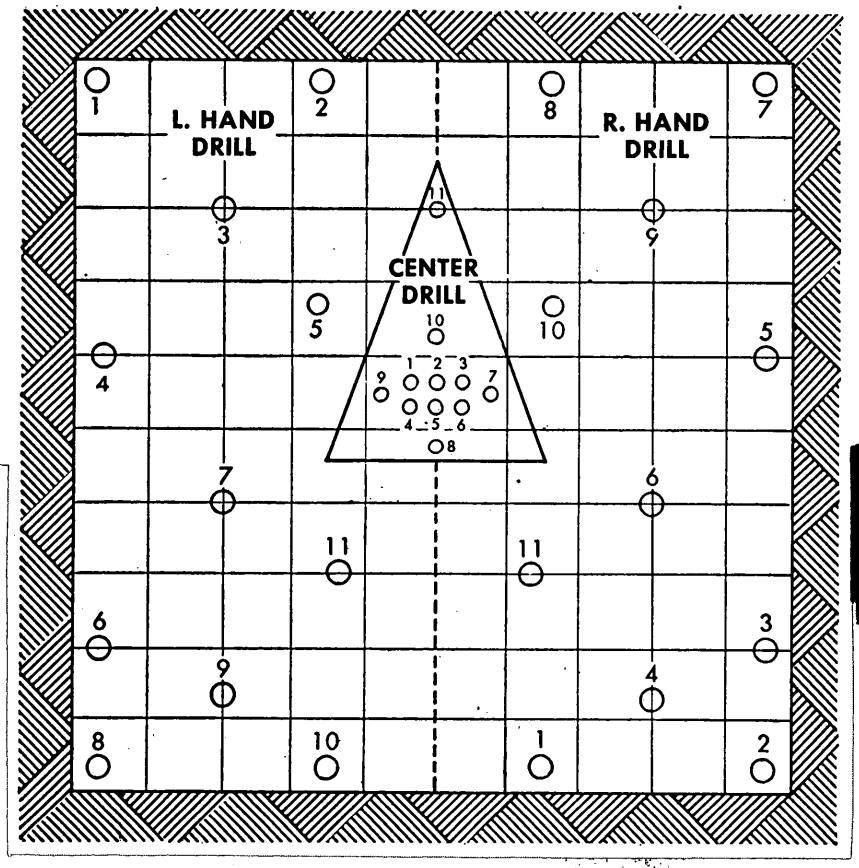
LE ROI COMPANY

RD-46

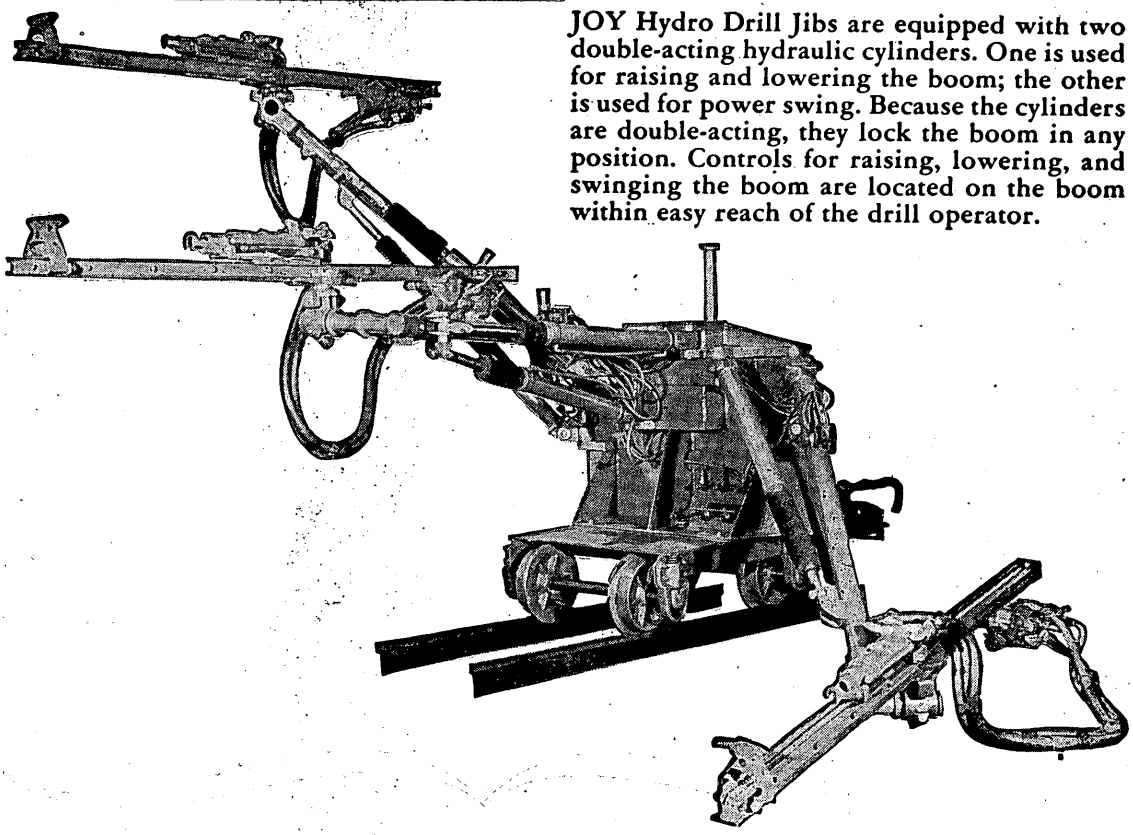
CLEVELAND ROCK DRILL DIVISION
12500 Berea Road, Cleveland 11, Ohio
Plants: Milwaukee, Cleveland and Greenwich, Ohio

"DRILL OUT THIS ROUND"

said the Joy Engineer.



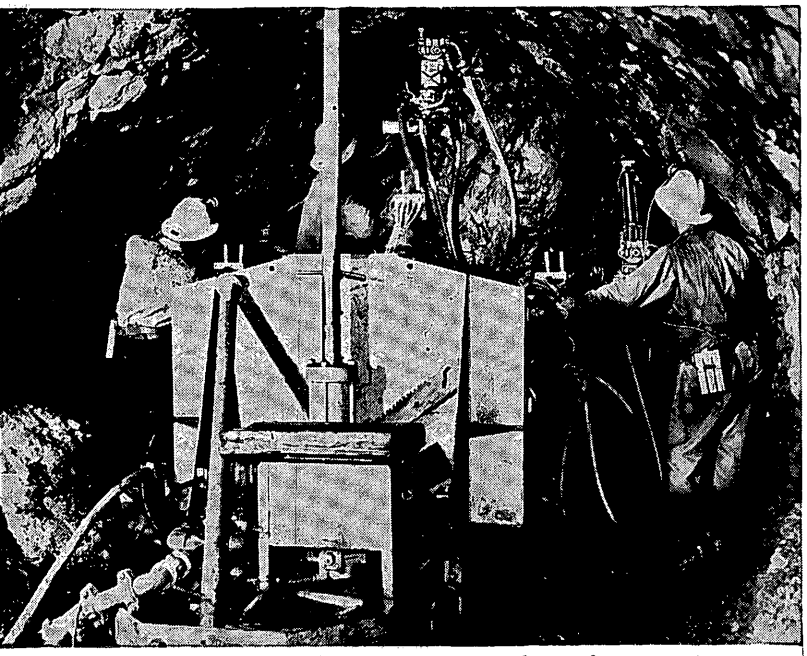
JOY Hydro Drill Jibs are equipped with two double-acting hydraulic cylinders. One is used for raising and lowering the boom; the other is used for power swing. Because the cylinders are double-acting, they lock the boom in any position. Controls for raising, lowering, and swinging the boom are located on the boom within easy reach of the drill operator.



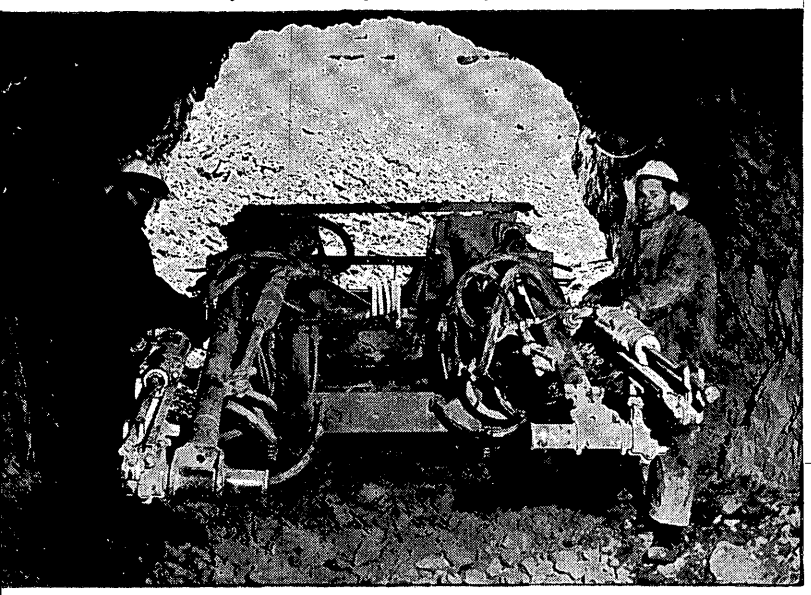
MAXIMUM VERTICAL RANGE WITH VARIOUS LENGTH BOOMS: 10 to 14 FEET

MAXIMUM LATERAL RANGE WITH VARIOUS LENGTH BOOMS: 18 to 28 FEET

"IN RECORD TIME and WITH LESS EFFORT with JOY HYDRO DRILL JIBS"



On the job in a heading: a JOY Jib Jumbo mounting three Hydro Drill Jibs with JOY T-300 drifters.



JOY builds a complete line of Jib Jumbos and Drillmobiles. Above: a twin-boom JOY Drillmobile, rubber-tired and self-propelled for quick, easy mobility.

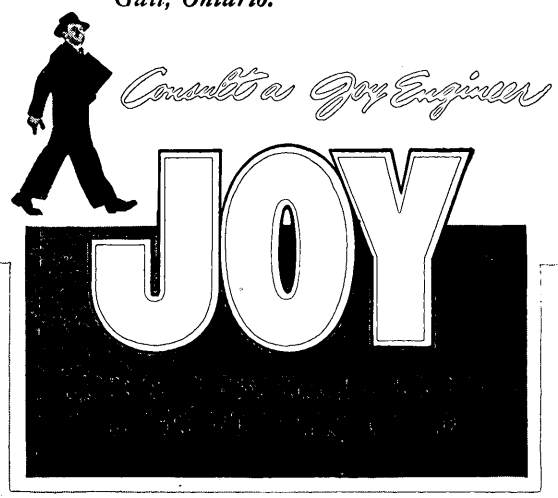
The recommendation above was made by one of Joy's drill mechanization specialists. He made it to a mining company which is now a satisfied user of the equipment recommended: four Joy Jib Jumbos (see facing page) each mounting three Joy T-300 Drifters on LW-6A long chain feeds. He went on to say—

"The LW 6A feed, easily supported by the Hydro Drill Jib, has an overall travel of 8 feet with a steel change of 6 feet. Thus, the proposed round can be drilled with one length of steel."

He then proposed and fully explained a drilling pattern (again see facing page) for a 10′ x 10′ round, showing the location of the eleven holes to be drilled by each one of the three jib-mounted drills. Basically, the plan provided for the least interference, and the maximum amount of drilling without dumping or swinging the drills. The holes for each drill were numbered so that the spreads between gave the runners plenty of working room. He closed by saying—

"The purpose of this proposal is to describe the many advantages of Joy fully automatic Hydro Drill Jibs. Joy pioneered the hydraulic drill jib and is still maintaining the lead in the design of this type of rig. We are keeping ahead with sound, practical improvements, and today believe we produce the finest drilling equipment available."

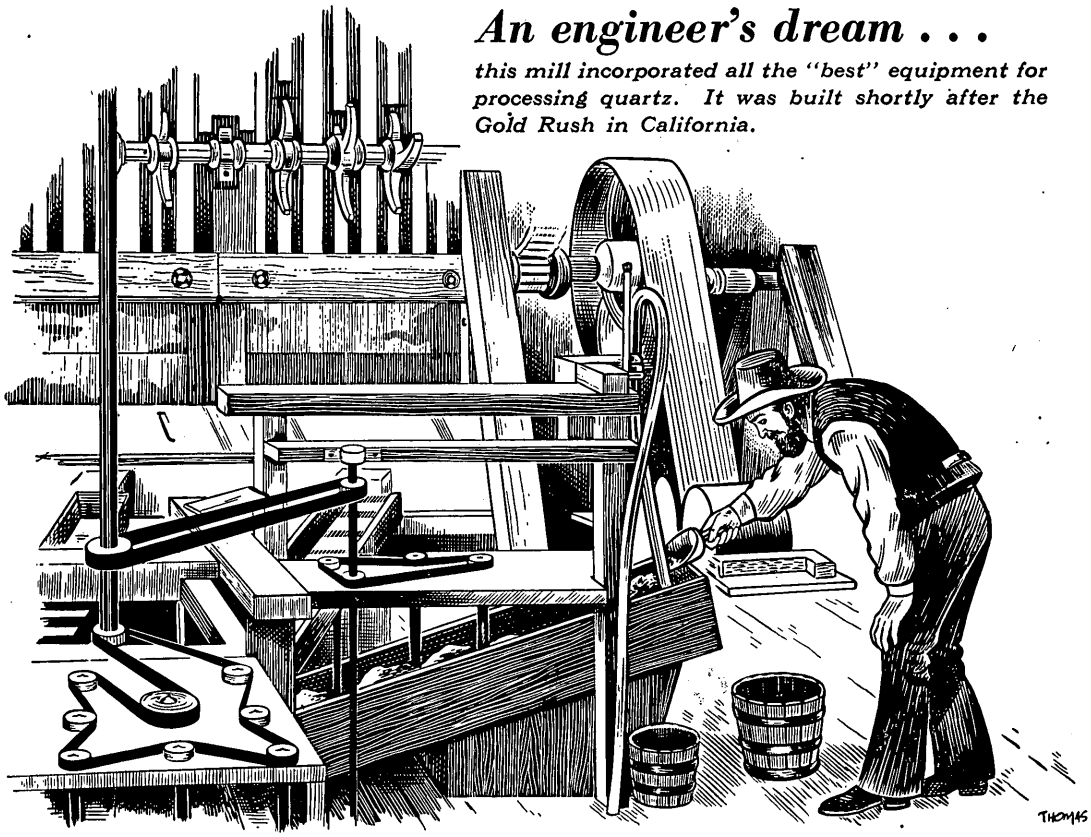
● Why not let a Joy drill mechanization specialist look over your problem and solve it the way he did this one? *Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa. In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

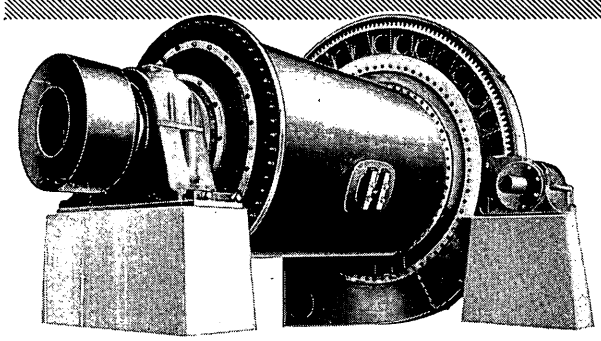


W&D CL-4302

An engineer's dream . . .

this mill incorporated all the "best" equipment for processing quartz. It was built shortly after the Gold Rush in California.





As great mining developments opened up in our country, the mining industry repeatedly devised more efficient methods to increase production. These improvements in technique came hand-in-hand with the invention of better equipment. For 50 years, Traylor has led in designing advanced crushing machinery to meet the growing demands of the industry. Mining men know that experience is their most dependable guide for matching machines with methods for best results. Traylor has experience . . . half a century of it.

Traylor builds Ball, Rod, Tube and Compartment Mills. Each type is produced in a wide variety of sizes to meet your exact needs.

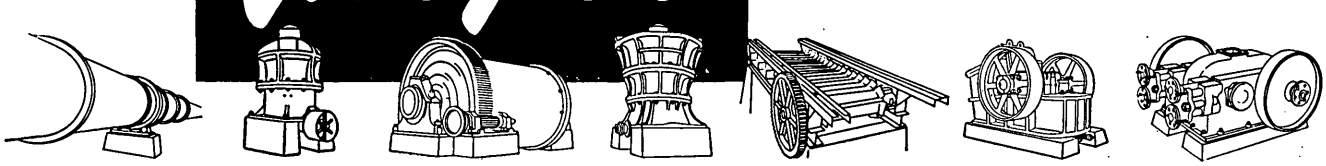
OUR GOLDEN ANNIVERSARY YEAR 1902 1952

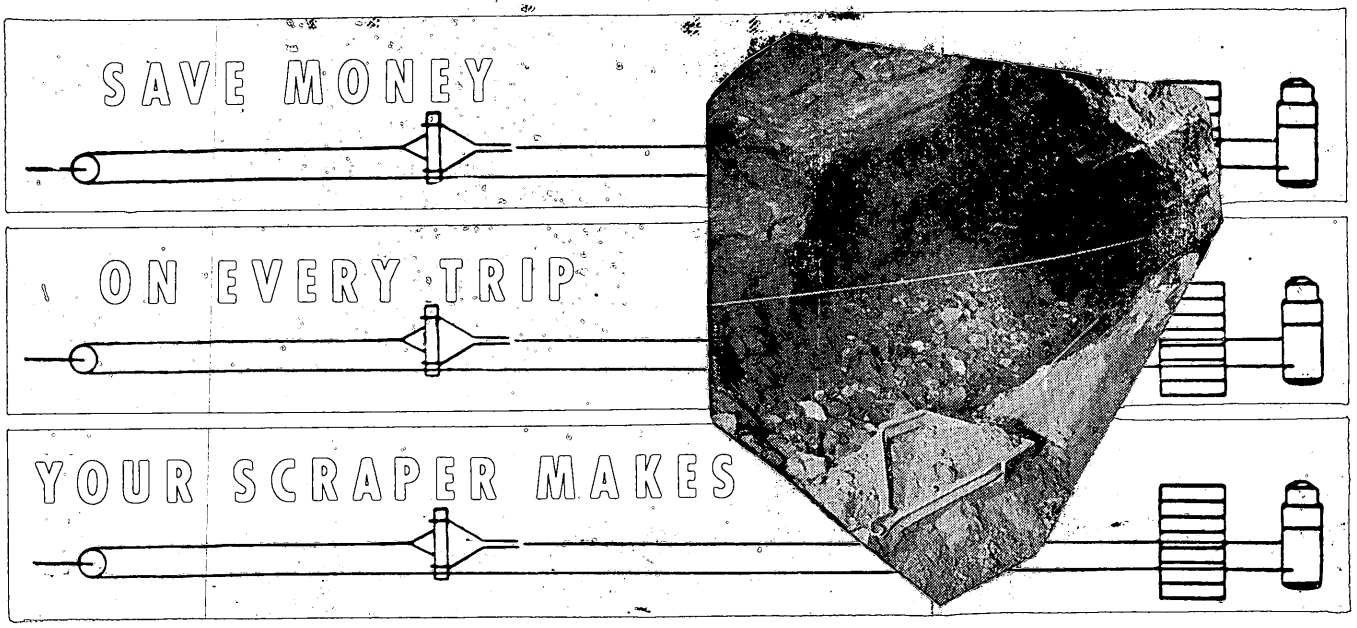
TRAYLOR ENGINEERING & MANUFACTURING CO.

1473 MILL ST., ALLENTOWN, PA.

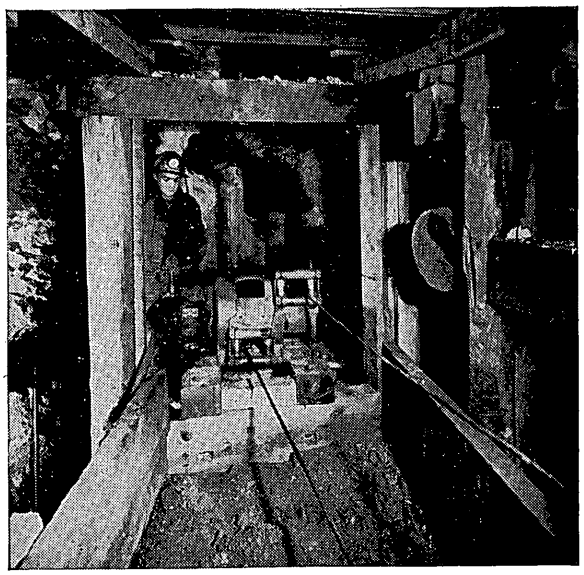
SALES OFFICES: New York, Chicago, San Francisco
Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P. Q.

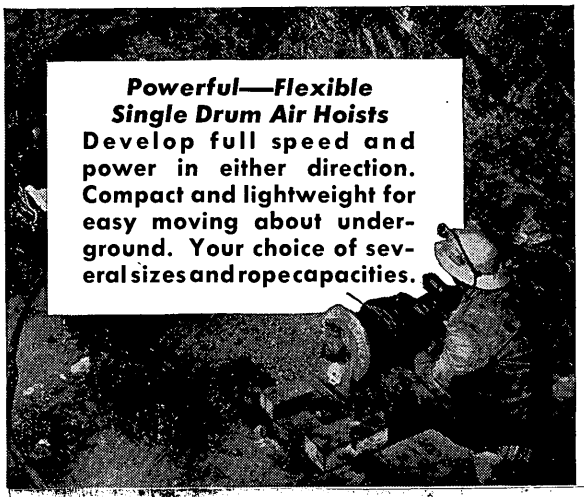
a **Traylor** *leads to greater profits*





WITH THE GARDNER-DENVER AIR SLUSHER





Powerful—Flexible Single Drum Air Hoists
Develop full speed and power in either direction. Compact and lightweight for easy moving about underground. Your choice of several sizes and rope capacities.

HERE'S HOW:

***Steady power*—for a full pay load every trip.**
***High speed*—for more trips per shift.**
***No air-waste idling* between trips.**
***Single throttle control*—readily mastered by your new miners.**
***Three sizes*—to fit your scraper capacity efficiently.**

Write today for Bulletin AS-3 on Gardner-Denver Airslushers and Air Hoists.

SINCE 1859

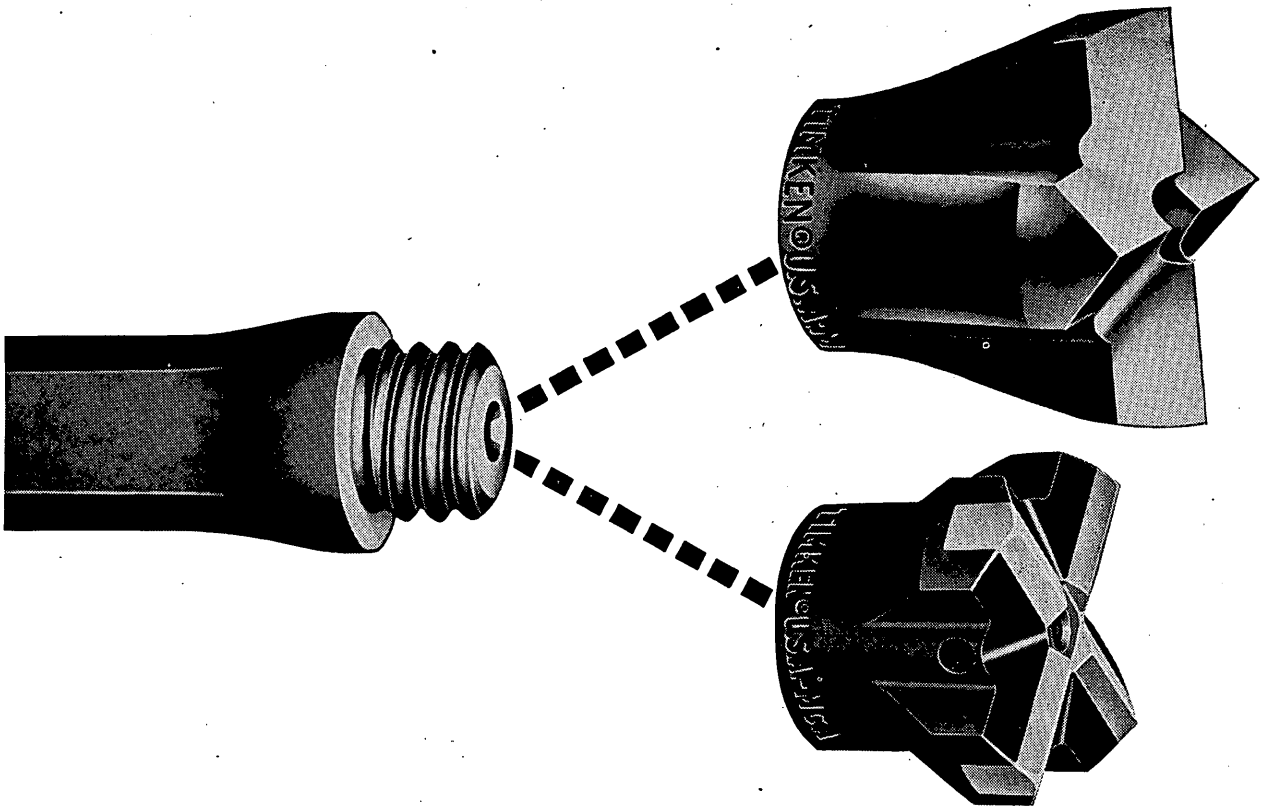
GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois, U. S. A.

Export Division: 233 Broadway, New York 7, N. Y., U. S. A.

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS

USE THE SAME STEEL FOR BOTH ROCK BITS!



Switch bits as the ground changes . . . right on the job!

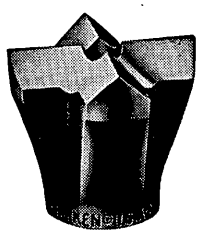
DRILLERS need only one steel on the job when they use Timken® rock bits. Both Timken multi-use and carbide insert bits, in the same series, fit the same threaded drill steel.

In drilling ordinary ground, Timken multi-use bits, when correctly controlled and reconditioned, give you the lowest cost per foot of hole when full increments of steel can be drilled.

When you hit hard, abrasive ground, quickly switch to Timken carbide insert bits for maximum speed and greatest economy. They're your best bet for very deep holes, small diameter blast holes and constant gage holes.

Both Timken bit types have three big advantages: (1) made from electric furnace Timken fine alloy steel, (2) threads are not subject to drilling impact because of the special union developed by the Timken Company, (3) can be changed quickly and easily.

If you're in doubt about the best bits for *your* job, call upon the 20 years' experience of the Timken Company's Rock Bit Engineering Service. Engineers will study your problem and recommend the most economical bit for your job. Write The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable address: "TIMROSCO".



Timken threaded multi-use rock bit

Timken threaded carbide insert rock bit

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

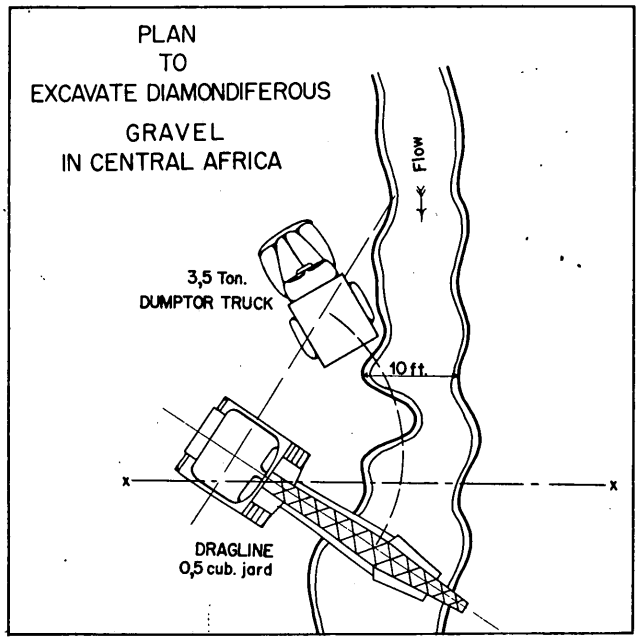
your best bet for the best bit . . . for every job

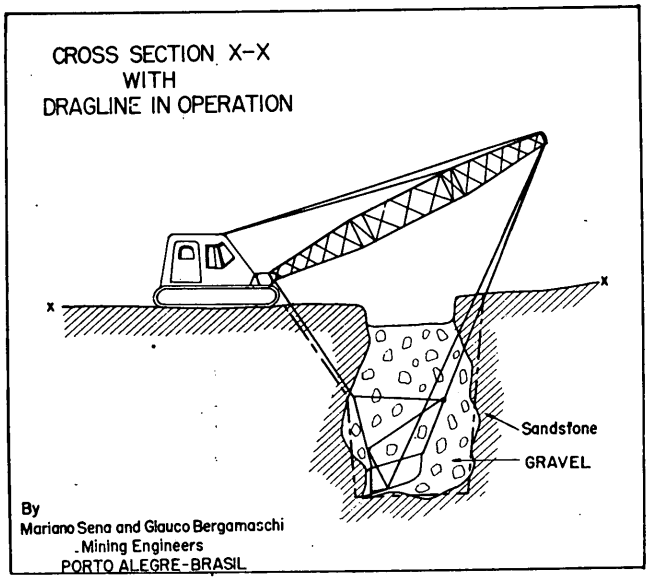
GRAB SAMPLES From the Mail

Diamond Mining Solution From Brazil

Dear Sir:

We have taken knowledge of Mr. Berger's diamond mining problem outlined on page 12 of the June 1952 issue of *Mining World*. We wish to present our solution as follows: Our viewpoint is that the diamondiferous gravel can be exploited with





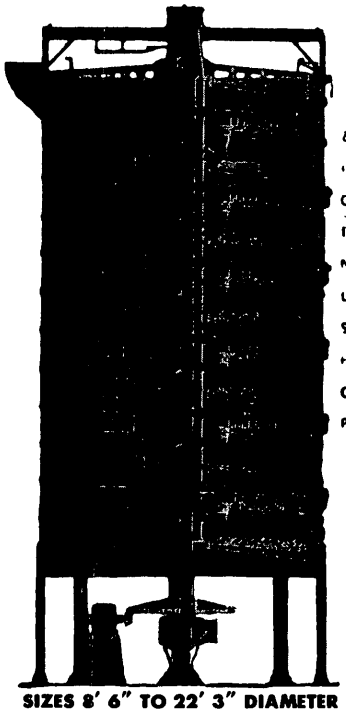
the aid of a ½-yard dragline and the gravel transported to the washing plant by means of a dump truck without the necessity of pumping out the river bed. Sandstone (stream bank) hardness was not mentioned but we presume that it would not interfere with the mining procedure outlined in the accompanying diagrams.

Mariano Sena Sobrinho, mining and civil engineer
Glauco Bergamaschi, mining engineer
Porto Alegre, Brazil

Thanks for this solution. It is being forwarded to Mr. Berger in Africa for his comments.—Ed.

PACIFIC FURNACE

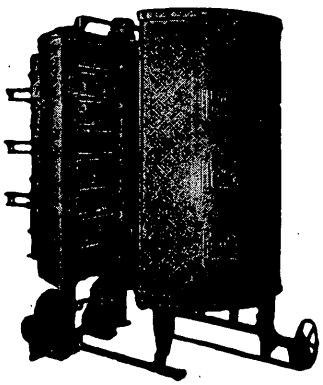
MULTIPLE HEARTH FURNACE



SIZES 8' 6" TO 22' 3" DIAMETER
NUMBER OF HEARTHS, 1-16

ROASTING
CALCINING
DRYING

ZINC ORES
IRON ORES
COPPER ORES
TIN ORES
NICKEL ORES
LEAD ORES
SODA ASHES
FULLERS EARTH
CARBON
PYRITE
QUICKSILVER
MAGNESITE
LIMESTONE
MOLYBDENUM
BONE CHAR
DIATOMITE
LIME SLUDGE
MAGNESIUM
CLAY GRANULES
ANTIMONY
SELENIUM
SEWAGE SLUDGE
LEAD CHEMICALS
METALLIC SLUDGES
FILTERING MEDIA
And for Numerous Other Materials

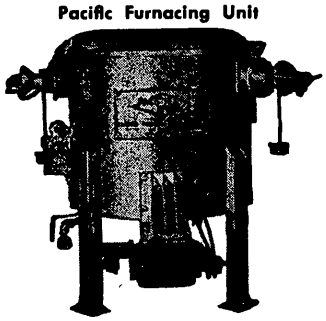


Pacific Laboratory Furnace

PACIFIC LABORATORY FURNACE

Manufactured in two sizes—36" and 54" inside diameters having 6-8-10 Hearths and include the same features as the commercial size furnace.

Pacific Furnacing Unit



NEW
PACIFIC FURNACING UNIT

Higher shell height. Three gas burners. Provision for conversion to muffle unit. Small volume roasts at any desired temperature.

PACIFIC FOUNDRY COMPANY LTD.
Engineers and Metallurgists

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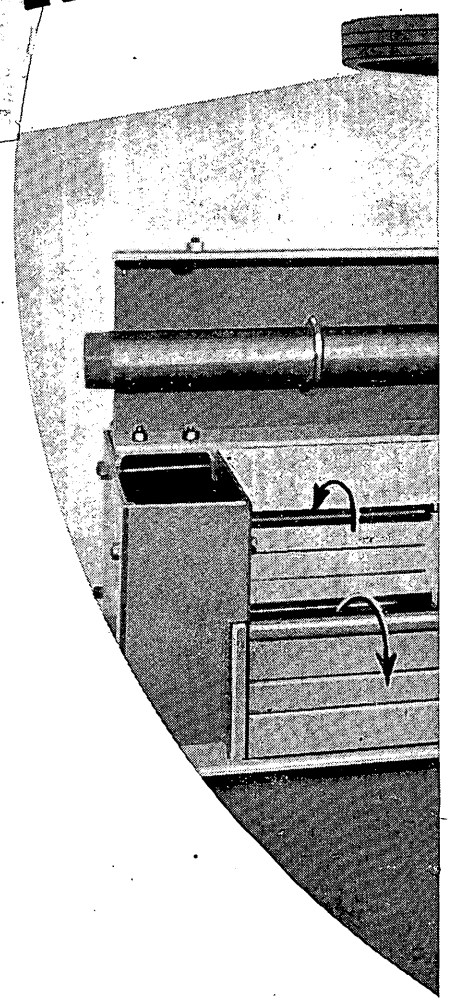
TODAY'S *New* FLOTATION FOR ROUGH

...by today's leader in flotation engineering



New Denver "Sub-A" Super-Rougher Flotation Machine gets you more values from roughing and scavenging circuits

You get more profits from your ore with the NEW Denver "Sub-A" Super-Rougher Flotation Machine—developed especially for low-grade ores. Yesterday's tailings may be today's profits, because of the price of metal. The Denver "Sub-A" Super-Rougher Flotation Machine is designed to get these extra profits out of your scavenging and roughing circuits!

This Denver "Sub-A" Super-Rougher Flotation Machine gives you the intense aeration necessary to get the most values from your roughing and scavenging circuits.

Controlled feed to the agitation chamber, supercharged aeration, an adjustable sand relief opening, and controlled pulp level give the flexibility in this low level, double overflow flotation machine that your flotation engineer *must* have for maximum results and profits.

Phone, write or wire today for more information! Find out how you can reduce tailings values and increase your mill efficiency by using Denver "Sub-A" Flotation—the world's leading manufacturer of flotation machines.

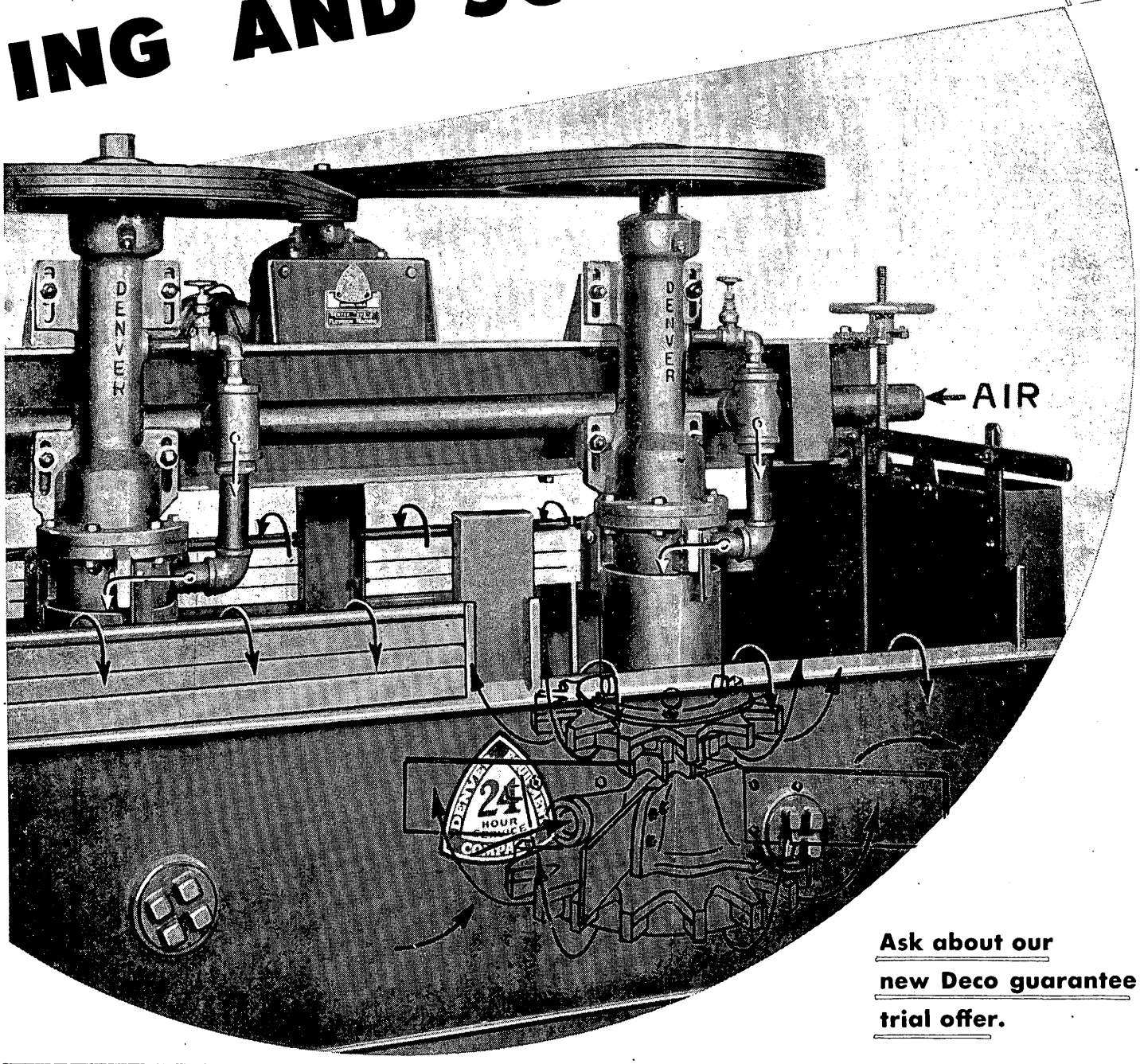
Patented and Patents Pending

DECO FLOTATION ENGINEER — DENVER EQUIPMENT COMPANY 24 HOUR SERVICE

DENVER®

OUR 25TH YEAR OF FLOTATION ENGINEERING

MACHINE
ING AND SCAVENGING!



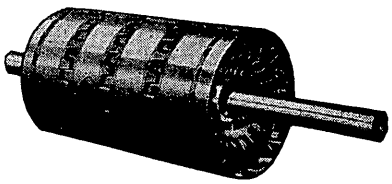
Ask about our new Deco guarantee trial offer.

EQUIPMENT COMPANY
1400 17th Street, Denver 17, Colorado

Which Answers Your Tramp Iron Problem BEST?

MAGNETIC PULLEYS?

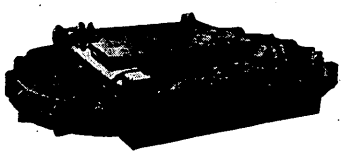
Powerful, air cooled electro magnetic pulleys are ideal where well loaded conveyor belts are used. Installed as head drive pulley, tramp iron is discharged automatically. Low operating cost, long life and extreme power characterize this workhouse of the Dings line. Catalog C-1001A tells you why this magnet is exceptionally efficient.



Dings *non-electric, self-energized* Perma Pulley magnets are recommended where burden depths do not exceed 3". Within this range, these are the magnets to use because of their unsurpassed concentration of magnetic strength near the surface. Catalog C-1007A.

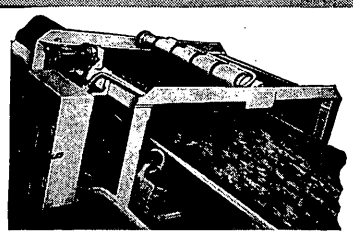
SUSPENDED RECTANGULARS?

Power close and power that searches down as deep as 30" to yank tramp iron out. If the Dings RM rectangular won't do it, it can't be done. Triple pole, double gap design. Install horizontally, vertically or at an angle above belt conveyors or in chutes. Self-cleaning fully automatic models also available. Write for details.



MAGNETIC DETECTOR?

The Dings Magnetic Detector instantly signals when any magnetic object large enough to be damaging passes through the detector zone. Can be hooked up to sound an alarm and stop the belt. Ideal protection for crushers, grinders, pulverizers, etc., where belt speeds are so excessive or burden depths so great no magnetic separator can function successfully. Detectors are available for belt widths from 18" to 72". Two types are available. One employs an electro magnet and the other, a permanent magnet. Performance of the two is comparable.



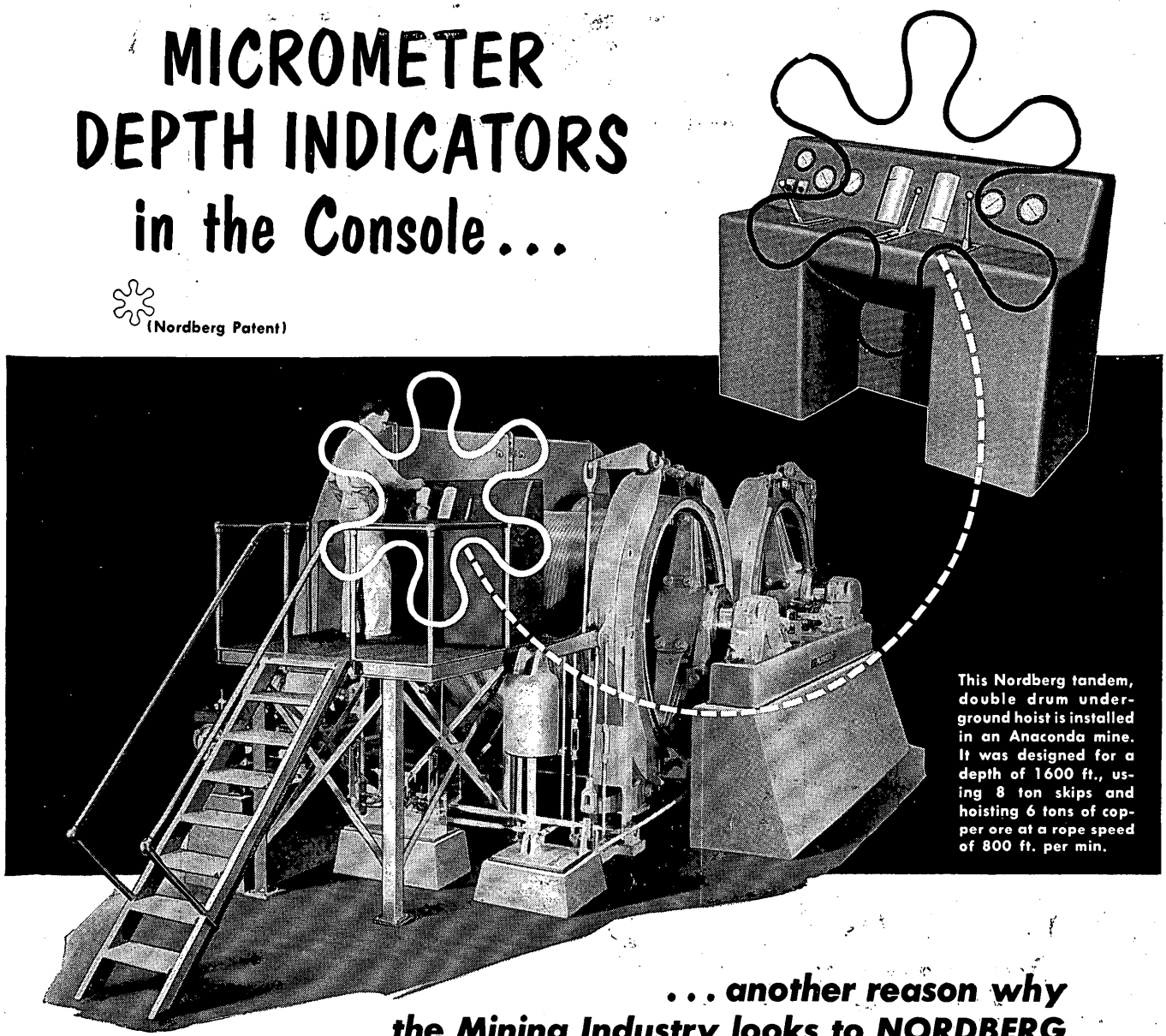
Magnets shown here are available in size ranges for most applications. Special magnets can be made for any application. Write today for recommendations.

DINGS MAGNETIC SEPARATOR CO.
4719 W. Electric Ave., Milwaukee 46, Wis.

Dings Certified MAGNETIC STRENGTH

MICROMETER DEPTH INDICATORS in the Console...

(Nordberg Patent)



This Nordberg tandem, double drum underground hoist is installed in an Anaconda mine. It was designed for a depth of 1600 ft., using 8 ton skips and hoisting 6 tons of copper ore at a rope speed of 800 ft. per min.

... another reason why the Mining Industry looks to NORDBERG as the leader in Mine Hoist design and development

● SINCE 1895, Nordberg has enjoyed worldwide leadership in the hoist field, specializing in building large or unusual hoists . . . and has been the source of the most progressive hoist engineering advances in the mining industry.

Micrometer Depth Indicators in the Console, for example, is just one of the advanced engineering features that has made Nordberg the leader in the design and development of modern mine hoists. This, and many other important engineering refinements, assures the very best in workmanship and materials to give you the ease of operation, safety and dependability which has made Nordberg Mine Hoists the standard for comparison.

No matter what your hoisting requirements may be, you will find that Nordberg hoist engineers are fully qualified to solve your specific problems. Write for further details, or send for Bulletin 190.

M552

NORDBERG MFG. CO., *Milwaukee, Wis.*

"SYMONS" . . . a Nordberg trademark known throughout the world

NORDBERG MACHINERY

NORDBERG

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MACHINERY FOR PROCESSING ORES and INDUSTRIAL MINERALS

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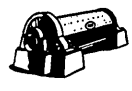
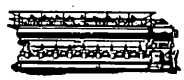
"SYMONS" Primary Crushers



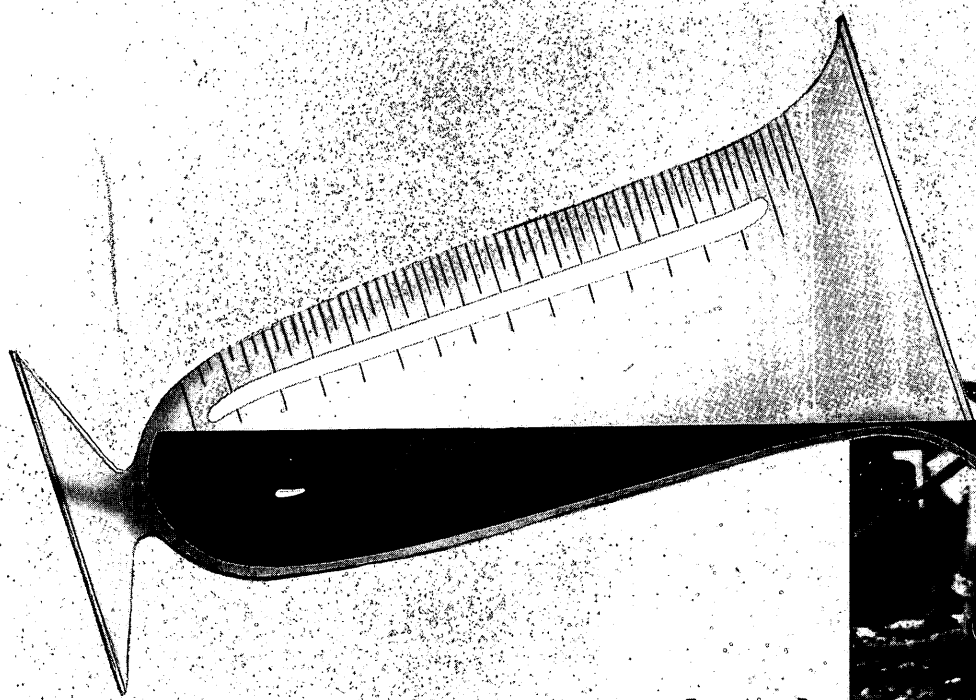
Grinding Mills

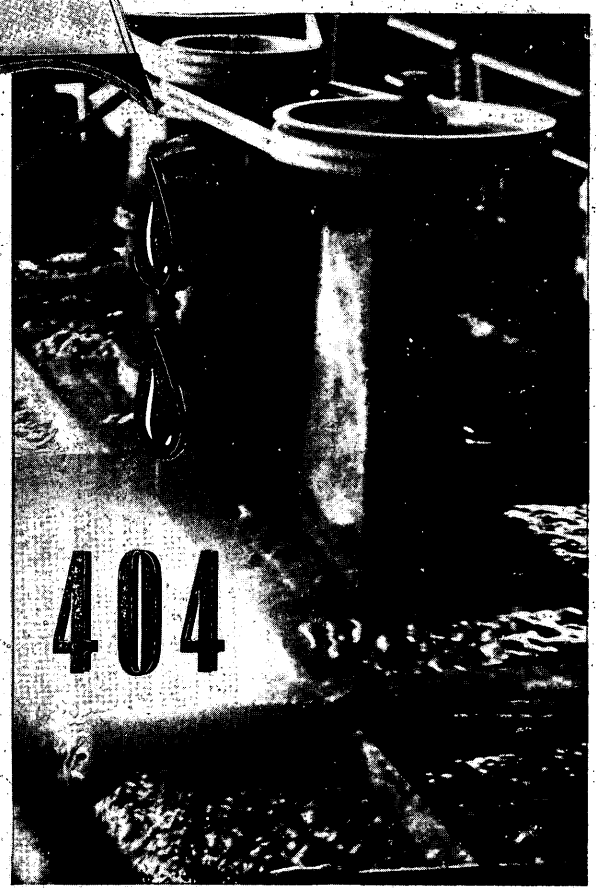
Mine Hoists

"SYMONS" Vibrating Bar Grizzlies and Screens



Diesel Engines





Have You Explored
All the Possibilities of

CYANAMID REAGENT 404

as a "Booster" or Replacement
for Traditional Promotors

Challenging time-honored ideas on reagent combinations, more and more metallurgists are sharpening selectivity, increasing recovery and reducing reagent costs by introducing Cyanamid Reagent 404 in their flotation circuits.

Fastest growing among the newer reagents in Cyanamid's complete line of metallurgical chemicals, Reagent 404 is already being used alone and in combination to beneficiate auriferous pyrite and pyrrhotite, tarnished and oxide lead, lead-zinc, copper-zinc, copper-lead, free gold, cobalt, antimony as well as other complex precious and base-metal ores. Each year, Reagent 404 finds new applications beyond its anticipated sphere of use.

Consider these four typical examples of the introduction of Cyanamid Reagent 404 as a "booster" or replacement for less effective promotors:

AMERICAN *Cyanamid* COMPANY

COPPER—PYRITE ORE, SILICIOUS GANGUE

PROBLEM: To reduce insoluble content of concentrate and increase copper recovery.

SOLUTION: Using Reagent 404 as part replacement of previous promotor produced these comparative test results in the mill.

		PROMOTOR lbs/ton	FROTHER lbs/ton	REAGENT COST	CONCENTRATE % Cu.	% Fe 0	% Insol.	TAILING % Cu.
Previous	Promotor X	.05	0.20	5.67¢	25.0	28.6	16.2	0.254
Present	Promotor X	.025	0.045	3.29¢	24.6	31.6	12.3	0.206
	Reagent 404	.032						

RESULTS: Reagent 404 lowers insoluble in concentrate and cuts reagent costs 42% (2.38¢ per ton of feed.)

PARTIALLY OXIDIZED LEAD ORE CONTAINING GALENA AND CERUSSITE

PROBLEM: To simplify the flow sheet and improve recovery of lead.

SOLUTION: Use Reagent 404 in place of usual type promotor and sulfidizing agent.

Product	ASSAY % Wt.	% Pb	% N-S Pb	% Distribution of Lead
Feed	100.0	11.05	2.91	100.0
Concentrate	16.6	65.0	——	97.6
Cleaner Tailing	4.4	2.23	——	0.9
Rougher Tailing	79.0	0.20	0.16	1.5

RESULTS: Excellent metallurgy with simple flow sheet and reagent combination. Water reclamation and circulation entirely feasible since Reagent 404 does not disperse tailing and thus interfere with thickening as would Sodium Sulfide. Galena and cerussite are floated in a single circuit, as compared with the necessity for two separate flotation circuits when a sulfidizing agent is used to recover cerussite.

AURIFEROUS PYRITE WITH NO FREE GOLD. CLEAN SILICIOUS GANGUE

PROBLEM: To increase recovery and reduce reagent cost.

SOLUTION: Use Reagent 404 as total replacement for promotors previously used.

		PROMOTOR lbs/ton	FROTHER lbs/ton	REAGENT COSTS	ASSAYS, Au, Oz/T FEED	CONC.	TAIL
Previous	Promotor A	0.10	0.07	5.23	0.129	5.16	0.006
	Promotor B	0.05					
Present	Reagent 404	0.05	0.05	2.60	0.175	5.07	0.005

RESULTS: Reagent 404 increases recovery of copper, lowers tailing by 3½¢.

GOLD—SILVER—LEAD—ZINC ORE

PROBLEM: To increase recoveries of gold, silver, and lead in the lead concentrate.

SOLUTION: Use of Reagent 404 as part replacement of previous promotor combination gave these comparative results.

		PROMOTOR lbs/ton	FEED, Oz/ton Au	Ag	% Pb,	Pb Conc. Oz/ton Au	Ag	% Pb	Recoveries, Pb Conc. Au	Ag	Pb
Previous	Promotor A	0.10	0.12	4.2	2.5	0.80	36.0	24.7	43.0	56.8	65.1
Present	Promotor A	0.04	0.14	4.4	2.6	0.83	31.1	22.3	51.8	59.4	71.6
	Reagent 404	0.02									

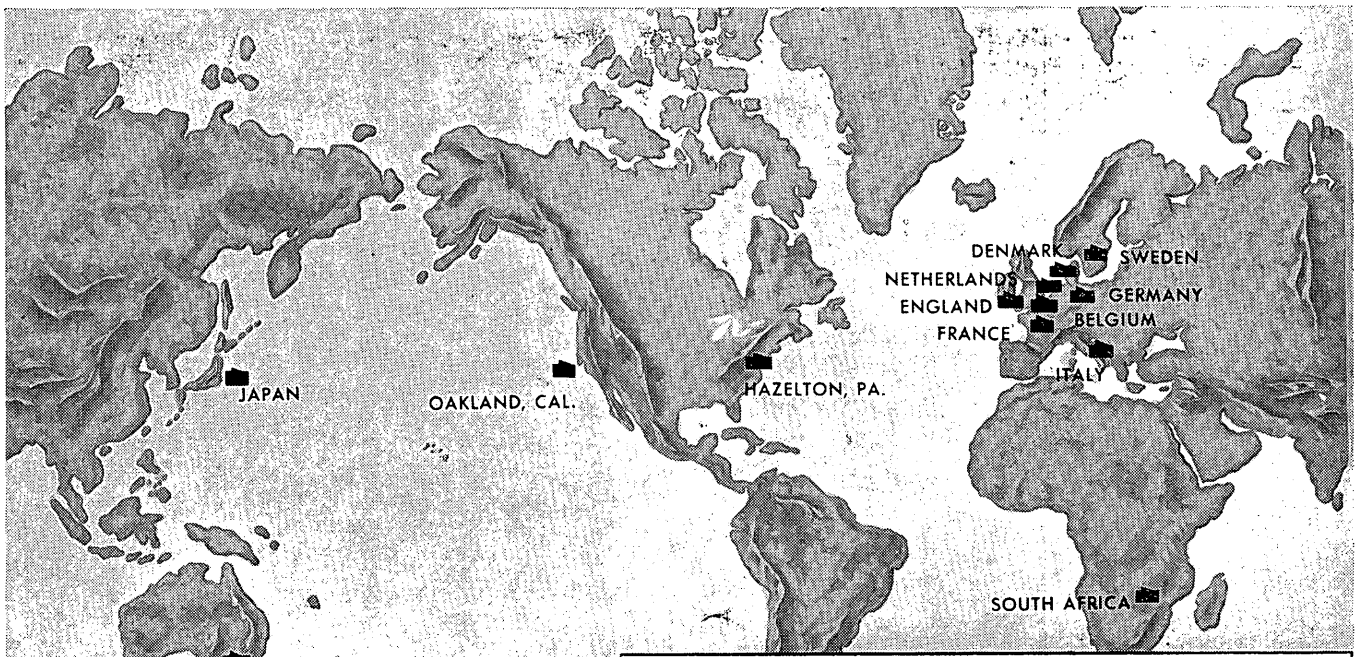
RESULTS: Use of Reagent 404 increased the recovery of Gold 8.8%, the recovery of silver 3.4% and the recovery of lead 6.5%. Simultaneously, reagents costs were reduced by 1¢ per ton.

An objective review of your reagent combinations and treatment methods in the light of recent milling developments may reveal that Cyanamid Reagent 404 (or its companion Reagents 425 and 444) can help you to achieve lower cost-plus-tails on your present ore now and make it economic to treat lower-grade mill feed in the future.

Cyanamid Field Engineers and Cyanamid Mineral Dressing Laboratory keep constantly informed on metallurgical chemical advances and flow-scheme modifications in every mining field the world over. They stand ready to give you unbiased counsel and practical help in your reagent studies . . . to bring you the benefits of Cyanamid's fundamental research, testing facilities and on-the-mill experience in applying more efficient reagents and processes. Your inquiry is invited.

MINERAL DRESSING DIVISION 30 ROCKEFELLER PLAZA NEW YORK 20, NEW YORK

Printed in U.S.A.



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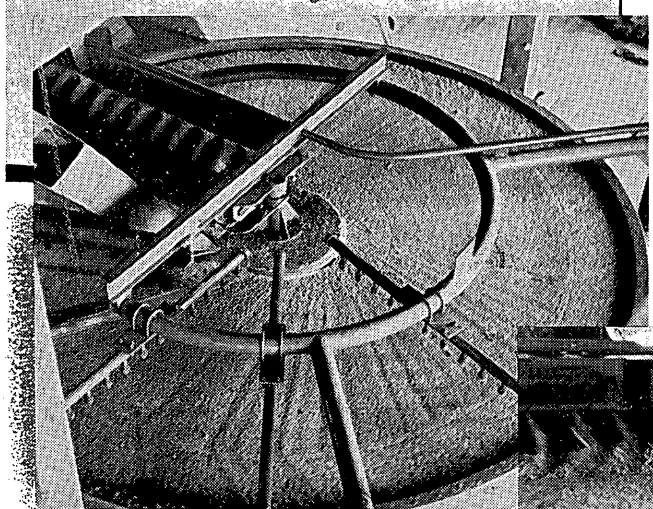
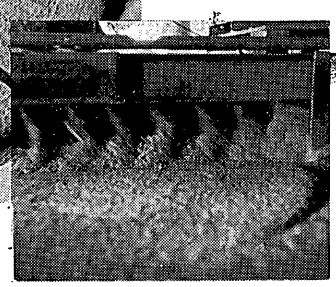
another strength of the Dorrco Worldwide engineering network





Built in Germany by Dorr Gesellschaft m.B.H., this four meter dia. Oliver Horizontal Filter handles 1800 metric tons per day of salt crystals. The small photo clearly shows the effective operation of the scroll discharger.

Oliver Filters are available through Associated Companies and Representatives of The Dorr Company in every mining area of the world except North America, Australia and the Philippines, where they are directly obtainable through Oliver-United Filters, Inc.

Strategically located facilities for the manufacture of Dorr and Oliver equipment are available in eleven countries of the world. These facilities for local fabrication, coupled with the sales engineering and technical services available through the following Associated Companies and Representatives of The Dorr Company abroad, provide a completely flexible network of engineering organization . . . established to serve worldwide metallurgy with maximum effectiveness.

We invite you to consult any of the following, or, if you prefer, address your inquiry to The Dorr Company at Stamford and it will be forwarded to the area best able to serve you.

In Europe: Dorr-Oliver Companies in England, Belgium, The Netherlands, France, Germany and Italy.

In South Africa: E. L. Bateman Limited, Johannesburg.

In India: Dorr-Oliver (India) Limited, Bombay.

In Australia: Hobart Duff Pty. Ltd., Melbourne.

In Japan: Sanki Engineering Co., Ltd., Tokyo.

In South America: Fiore Company in Buenos Aires; Serva Ribeiro in Rio de Janeiro and Sao Paulo; John Lindsay in Caracas; and conveniently located Dorr Resident Engineers.

Better tools TODAY to meet tomorrow's demand

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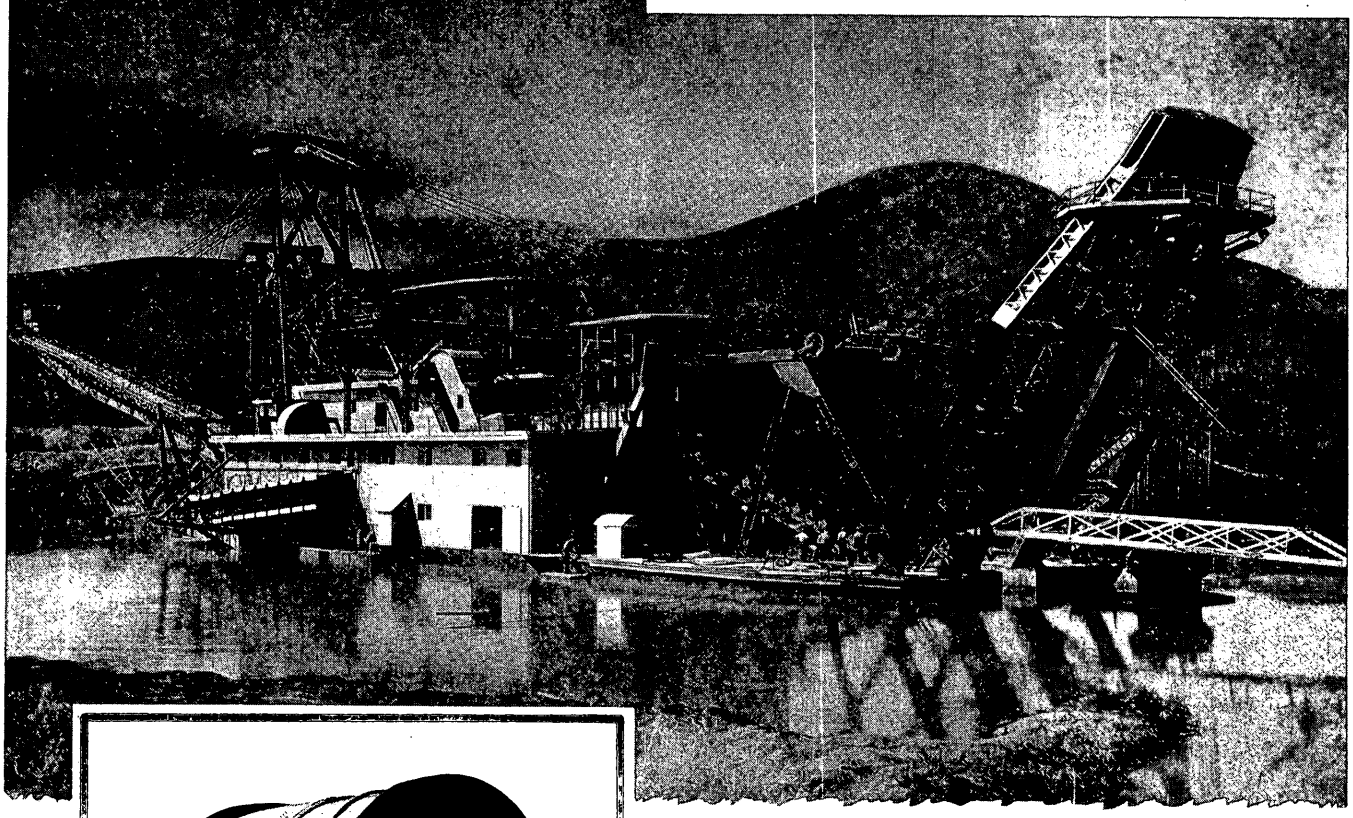
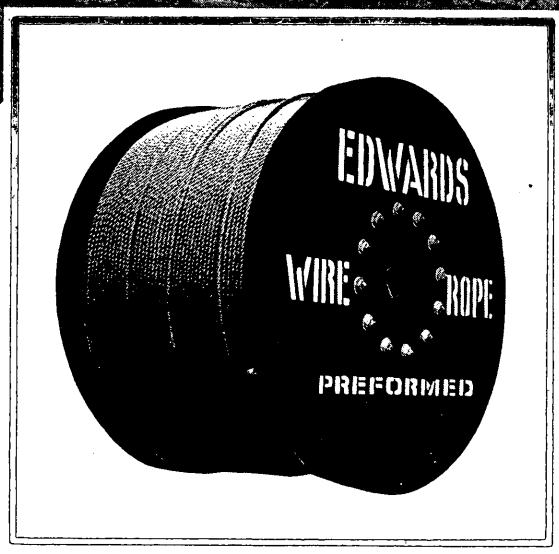
Rig for profitable dredging

with Edwards Wire Rope

To get the tough, durable wire rope required for safe, continuous operation specify Edwards Wire Rope for bow lines, guy lines, stacker lines, stern lines—for all lines used in dredging.

There's an Edwards rope in the size, grade and construction you need for every mining job, whether on dredging, shaft or open pit operation. Select the *right* rope from the complete Edwards line.





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E. H. EDWARDS COMPANY

General Office: **South San Francisco, California**

Los Angeles • Houston • Seattle • Portland

You get more ore every shift with the

SMOOTH, FAST WORK CYCLE

of Bucyrus-Erie's 38-B

Most Compared . . .

BUCYRUS ERIE

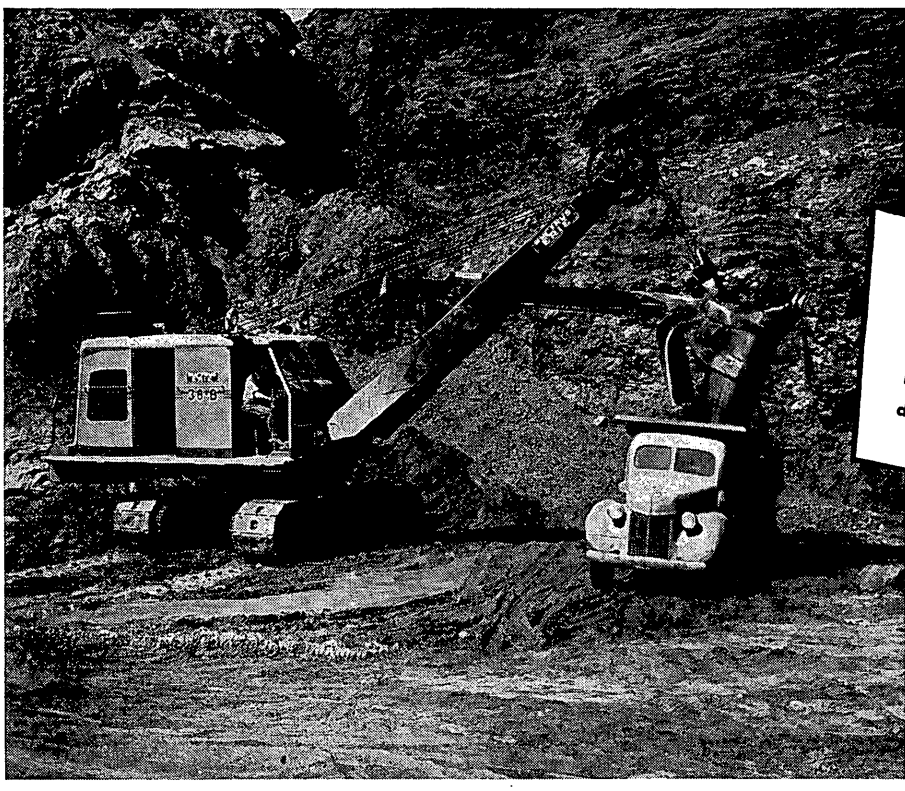
Most Preferred

SPEED is a traditional characteristic of Bucyrus-Erie excavators . . . and speed in the individual dig, swing and dump operations only tells part of the story.

In the Bucyrus-Erie 38-B, working speed starts on the drawing board, where cycle functions are balanced with one another (as well as being designed fast in themselves) . . . and coordinated with proper weight distribution. Adding smooth, steady power . . . liberally used anti-friction bearings . . . easy-filling dippers . . . and direct-action mechancial control gives it the overall production speed that has made Bucyrus-Erie the standard of the industry.

Eliminating lost time and waste motion is one big way to boost output *wherever* excavators are used. Now . . . when that counts more than ever, you can count on Bucyrus-Erie excavators to "deliver the goods." 88E52

BUCYRUS-ERIE, South Milwaukee, Wisconsin



True simplicity of design, with large, strong parts make the Bucyrus-Erie 1½-yd. 38-B an outstanding mining machine . . . both for efficiency and dependability.

for lower **first** and **last** costs

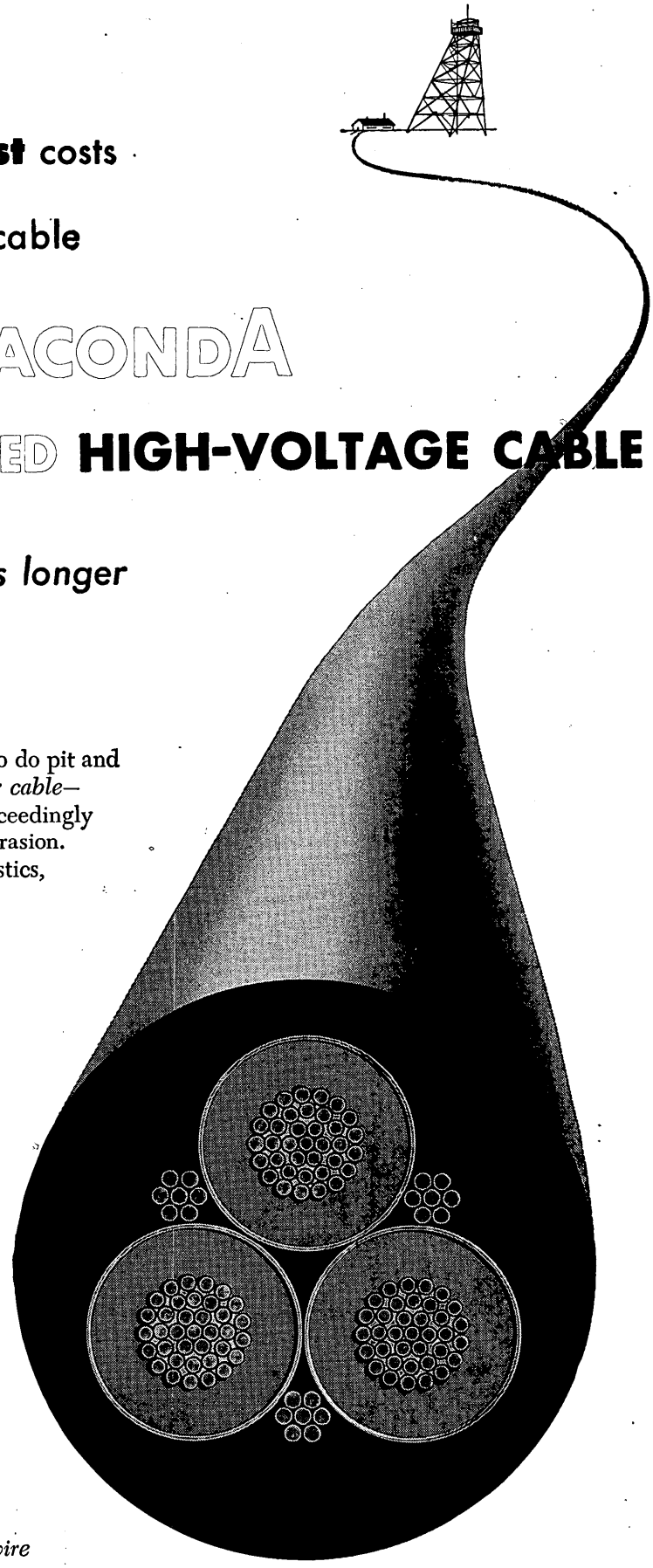
power with this tough cable

ANACONDA

BUTYL-INSULATED **HIGH-VOLTAGE CABLE**

—easier to install—lasts longer

—handles better



Mine after mine comes up with the same answer. So do pit and quarry operators. *It pays to use this modern power cable—* ANACONDA Type AB*, for uses up to 15 kv. It is exceedingly hard to damage by impact, crushing, twisting or abrasion. Butyl insulation has superior long-aging characteristics, improved resistance to moisture, ozone, heat. Neoprene jacket—as tough as they come—has real flexibility and great strength. This cable handles well and lasts longer in all weather. It has high dielectric strength, affords excellent protection against acids, oils, and even flame.

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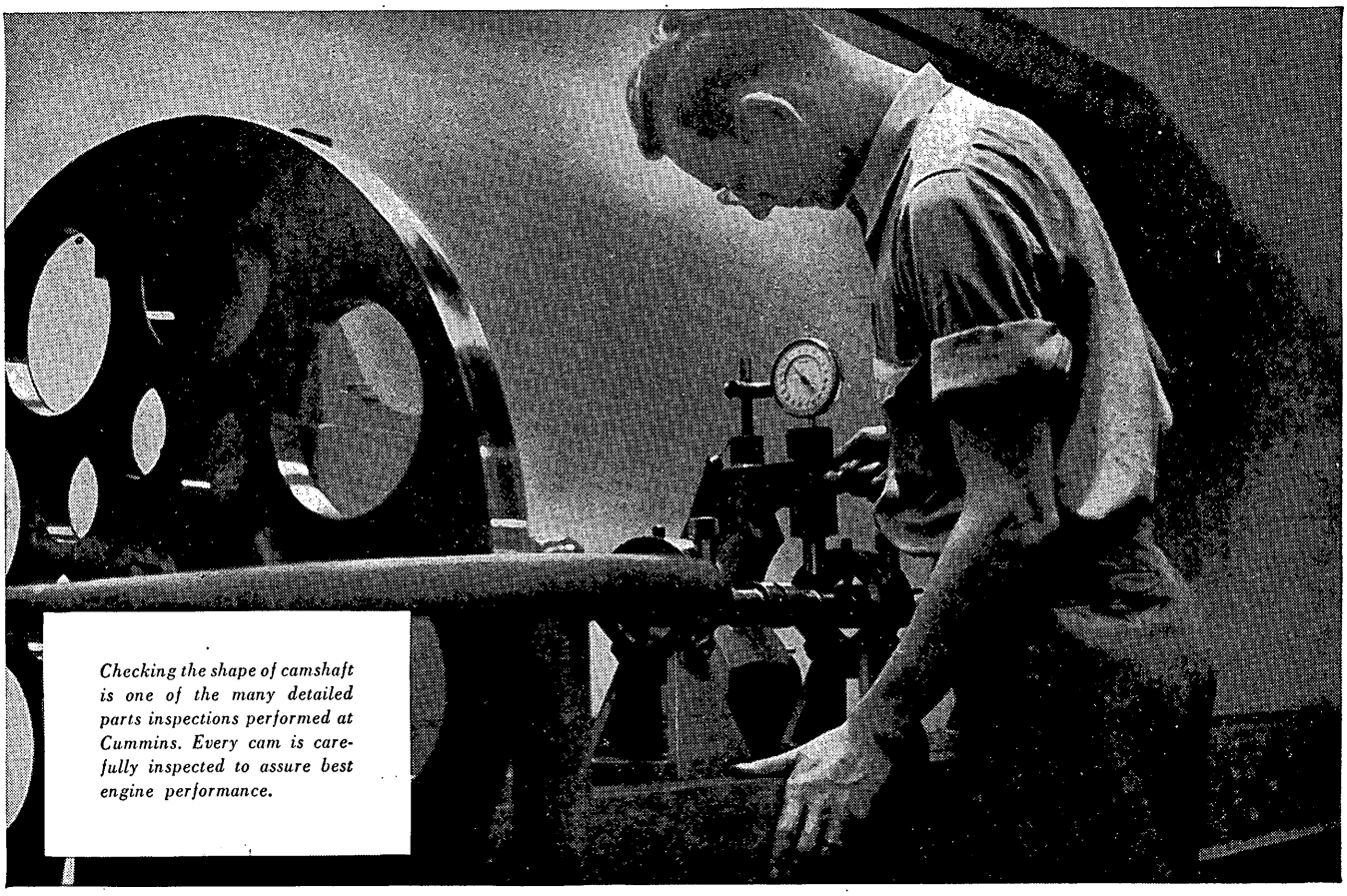

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(9-22-52)

MINING WORLD

and the export edition

WORLD MINING

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NOVEMBER, 1952

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GENERAL MANAGER, San Francisco..M. F. HOLSINGER
EDITOR .....GEORGE O. ARGALL, JR.
FIELD EDITOR .....R. L. BURNS
NEWS EDITOR .....J. M. TAYLOR
EASTERN MANAGER, Chicago.....KAREL WEGKAMP
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DRIFTS AND CROSSCUTS

Why Not a Flexible Zinc Tariff?

The recent drastic drop in the price of Prime Western zinc to 13.5 cents per pound, East St. Louis, has already caused nine shutdowns in the Tri-State district, Arizona, Idaho, New Mexico, and other states. Between 20 and 40 percent of domestic production is threatened at this price.

The "rule of thumb" for producers at present labor and supply costs is that a combined zinc plus lead price of 30 cents is necessary for the domestic industry to perpetuate itself; that is, to develop a ton of ore for every ton mined—not even to expand reserves. With zinc at 13.5 cents and lead at 14.0 cents, immediate production is being lost. Of greater national consequence, exploration and development, always first to be curtailed, are of necessity being suspended at many mines.

There is need to emphasize the danger to the nation's security under this situation.

Whose purpose is furthered by the cut in the zinc price?

Whose mines will be closed—domestic or foreign?

The present zinc-in-ore duty is 0.6 cent per pound and 0. ⅞ cent on metal.

Is this part of an overall conspiracy?

There are those that say it is, that it is part of an overall plan, and that the Paley Report with its advocacy for foreign minerals is a part.

There is no question but that large consumers want cheap metal, and they eagerly eye the more than 50,000 tons of surplus zinc in Europe, much of which was initially purchased at high prices.

Another part of the picture is the drive by the internationalists to sell their products abroad for dollars, i.e., cotton and automobiles. They have no feeling about crucifying the domestic mineral raw materials producers if dumping of foreign metal will export dollars which can in turn be used by foreigners to purchase their goods.

It would appear that now is the time for the government to step in and buy zinc.

Initial government requests to buy Prime Western zinc for the stockpile found that certain interests were not selling to the government. Why?

There are those who say why doesn't the government establish a parity on zinc? Buy when the price is low. If the prophecy of the government's own Paley Report is correct, the government should make money in the long run.

Better yet—Why doesn't the mining industry cooperate and submit to congress a proposal for a flexible tariff to automatically maintain, within reasonable limits, the price level the domestic mining industry must have to perpetuate itself?

COMING CONVENTIONS

November 6 to 8, 1952. FIRST ANNUAL SOUTHWEST MINERAL CONFERENCE, sponsored by the New Mexico Mining Association and the Southwest International Mining Association. Alvarado Hotel, Albuquerque, New Mexico.

December 2, 1952. Annual meeting AMERICAN MINING CONGRESS, University Club, New York, New York.

December 5 and 6, 1952. NORTHWEST MINING ASSOCIATION, annual convention, Davenport Hotel, Spokane, Washington.

February 12, 13 and 14, 1953. Mining Conclave and Convention, COLORADO MINING ASSOCIATION, Shirley Savoy Hotel, Denver, Colorado.

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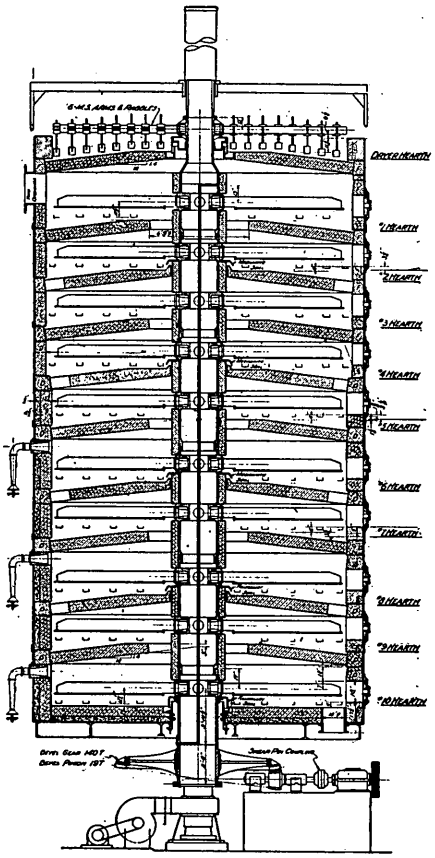

SKINNER ROASTER GENERAL ARRANGEMENT

The Skinner Roaster, as manufactured by CIW, has produced outstanding results for many years on roasting and calcining ores, clays, limestone, limestone mud; decomposing oil sludge to recover sulphuric acid; incinerating sewage, either as garbage or digested sludge to inert ash. Coal, oil or gas fired.

IMPROVED DESIGN

The current models include all of the advantages of the well-known Skinner Roaster . . . easy access during operation; quick replacement of rabble arms and teeth without cooling; cross draft and multiple gas off-takes provide wide range of temperature control.

In addition, an improved bearing arrangement results in greater efficiency and lower costs. The top guide bearing is self-lubricating; the bottom is totally enclosed spherical roller type.

It is available in sizes from 3½′ inside diameter experimental model, with 4, 6 or 8 hearths; up to 22′ with as many as 12 hearths.

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DMPA EXPANSION PROGRAMS NOT AS GOOD AS STATISTICS

In a recent press release, Administrator Larson of DMPA nearly broke his arm patting himself on the back. "It should be emphasized," Larson said, "that this is not just a government program. It is a government-industry program. In my estimation, the expansion that has been accomplished so far represents one of the finest demonstrations of government-industry teamwork that the country has ever seen."

Larson then went on to say: "The list of projects includes 53 for copper; 29 for the ferro-alloys (chromium, cobalt, manganese, molybdenum, and tungsten); 92 for lead, zinc and cadmium; 5 for tin; 3 for titanium; and 131 for a dozen or more nonmetallic materials." In all, he stated, 436 expansion programs to boost the domestic production of metals and minerals were approved by DMPA during the fiscal year ending June 30, 1952. As the agency was not in existence during all of that year, Larson must also include DMA projects.

The record sounds good, although it is poor beside the old WPB accomplishments. The trouble is that unanalyzed statistics of this sort mean little until explained in detail.

For instance, DMPA may approve an expansion program and RFC refuse to loan the money. In that case the project might just as well not have had DMPA's blessing. Also, it would be interesting to know if the 53 copper projects include those to "maintain" production, rather than to expand it. Of the 19 defense loans to mining enterprises certified to RFC by DMPA, only seven had received any money up to September 15, 1952, and at least several were certified to RFC back in 1951. Of the something over $5,000,000 disbursed to the seven projects by RFC, six of them together had received less than $500,000 to the date above mentioned.

No doubt careful research into the Larson figures would reveal some other interesting facts. It is too bad that at present there is no committee or subcommittee of Congress interested in digging into the details—as the Engle mining subcommittee used to do.

• Higher Tungsten Goal Is Set

From a requirement of 9,000,000 pounds of tungsten in 1950, the Munitions Board now has came up with a figure of 40,000,000 pounds by 1954. As there seems to be no inclination on the part of DPA or DMPA to revise the tungsten program and price to a point where many domestic producers can participate, it follows that most of this will be purchased abroad.

• Who Collects The Tax Dollar?

Strange as it may seem, there was a day when taxes did not hurt. As recently as 1939 the average family paid only $397 as its share of all taxes—local, state and federal. Today, just 13 short years later, the bill is $1,934.

Who is drilling the hardest on the tax nerve? You guessed it—the federal government. A comprehensive study reveals that in 1939, state and local governments collected 63 percent of all revenues. Washington collected the remaining 37 percent.

Now the picture is reversed. State a[illegible] add up to only 29 percent of the total, while the federal government takes 71 percent—or $1,389 of the $1,934. Even at that, state and local taxes have tripled since 1939. Federal taxes are 12 times as high.

• RFC Makes Few Disbursements For Minerals

It is a sad commentary on the DMPA-RFC approach to the Defense Production Act and the defense effort that total disbursements by the RFC up to September 15, 1952, aside from the White Pine Copper Company loan, have been less than $500,000 dollars. To be exact, only $465,719.64 has been forthcoming to stimulate domestic production of critical and strategic minerals under Section 302 of the Act. This would not make one good day's work for the Foreign Expansion Division.

• DMEA Has Top-Notch Team

It was cheering to note the Interior Department's press release which reported that at long last C. O. Mittendorf had been promoted from "acting" to actual administrator of the Defense Minerals Exploration Administration. Within the policy limitations laid down for him by Interior and DMPA, and considering the millstones of the U. S. Bureau of Mines and the United States Geological Survey dangling about his neck, Mittendorf has done a splendid job, both technically and organizationally.

More recently, announcement has been made of the appointment of Frank E. Johnson as deputy administrator. Anyone who has done business with Johnson in the days of Metals Reserve Company, and since, will heartily approve.

Mittendorf and Johnson make a team in a government agency which will be greatly appreciated by industry.

• Removal of Price Ceiling Is Discussed

Reports indicate that the NPA and OPS at last are discussing seriously taking the price controls off copper. The opinion of DMPA Administrator Larson for a long time has been that price controls should be removed and he was quoted recently as saying, "The trouble with this whole situation is our foolish domestic price ceiling." That has been only part of the trouble, but the admission will do for the moment.

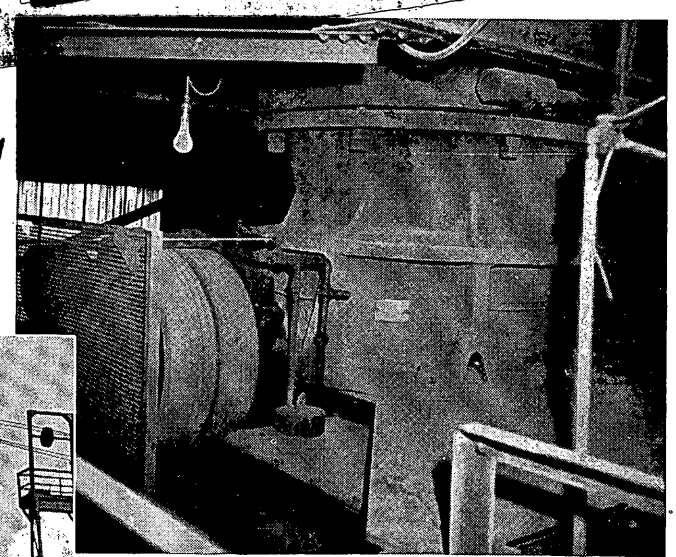
• Tungsten Figures Show Small Results

The results of the government's tungsten program in increasing domestic supplies are quite astonishing. Under the World War II program, domestic production in 1943 was 12,055 short tons of 60 percent WO_3. In 1951, domestic production was 6,214 short tons. The production figures for the first six months of 1952 list domestic production at only 3,397 short tons.

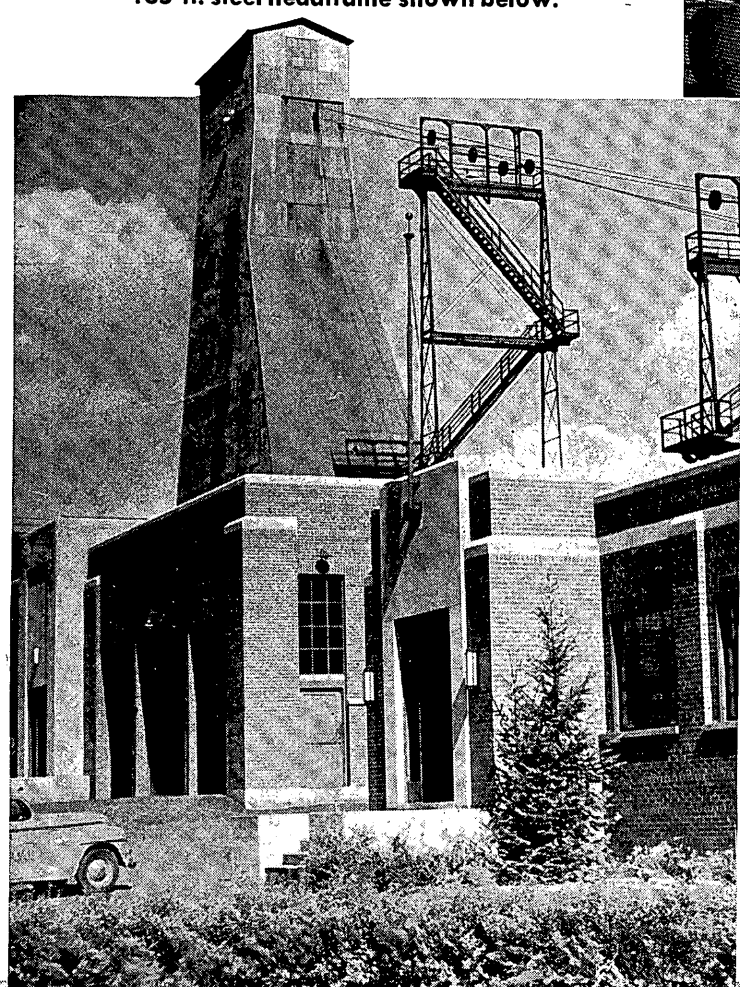
• Paley Report Is Under Fire

Now that some, at least, of the Paley Report has been digested by the mining industry, various critical analyses of its "facts" and figures are being published. It appears that the crystal ball dated 1975, which revealed the future so clearly to the commission's staff and members, was slightly cracked and cloudy in spots.

OVER 3,000,000 TONS HAVE BEEN CRUSHED by this TELSMITH



The 13-B Telsmith Gyratory Crusher is located in the upper part of the 135-ft. steel headframe shown below.



An important iron ore producer in the Iron River district of the Menominee Range in Michigan finds his Telsmith Gyratory Crusher to be exceptionally economical.

Installed in 1942, this Telsmith 13-B Crusher handles about 35,000 tons of ore per month, and to date has crushed over 3,000,000 tons. Crusher upkeep expense has been exceedingly low, consisting of only one set of eccentric bearings and some very minor parts. For details on Telsmith's bigger capacity and lower upkeep, get Bulletin 271.

Min.-34

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INTERNATIONAL PANORAMA

WASHINGTON—The Defense Production Administration has revised its tungsten ore goal upwards for 1954. The new goal calls for 40,000,000 pounds of contained tungsten from all sources compared to an earlier goal of 34,000,000 pounds.

ANKARA—Turkish prospectors for chrome have more than doubled in number. Applications for mining permits in 1950 were 4,280 and in the first six months of 1952 were 8,290.

JOHANNESBURG—South Africa's first byproduct uranium plant has been placed in operation. The plant costing more than $4,000,000 will treat gold tailing at the West Rand Consolidated Mines, Ltd.

RIO DE JANEIRO—Production of high-grade iron ore during July at the Itabari mines of the Companhia Vale de Rio Dôce was at an all-time peak rate. A total of 169,869 tons were mined and 151,789 tons were exported.

WALLACE, IDAHO—Shortage of electric power has caused curtailment of electrolytic zinc refining operations by Sullivan Mining Company. Production loss may be 1,000 tons per month for several months.

LISBON—Beralt Tin and Wolfram Limited has signed a contract for sale of 2,500 long tons of tungsten (wolframite) concentrate to the United States government. The contract calls for deliveries for five years beginning from October 1, 1952.

GALENA, KANSAS—The Eagle Picher Company will construct a $4,000,000 zinc concentrate roasting and sulfuric acid plant here. When completed in 1954, the new facility will produce about 240 tons per day of sulfuric acid.

BUTTE, MONTANA—The United States Steel Company has taken an assignment of a 99-year lease on 11 fluorspar claims southeast of Darby, Montana. Shipments of metallurgical fluorspar are being made to the Geneva, Utah, steel plant.

TOKYO—Production of electrolytic copper in Japan during August was 7,825 metric tons. This is the lowest monthly output for 1952.

PITTSBURGH—Production of steel in the United States during the third week of September was the greatest in history—2,160,000 tons of ingots and castings.

FALLON, NEVADA—The Kaiser Aluminum & Chemical Corporation has begun operation of its new fluorspar flotation mill here. Acid-grade concentrate will be shipped to Pittsburg, California, where it will be converted to aluminum fluoride.

WASHINGTON—Fourth quarter 1952 allocations of copper, nickel, and cobalt by the International Materials Conference are larger than for the third quarter. Greatest increase is in cobalt where 2,890 metric tons are allocated compared to 2,475.

LA PAZ, BOLIVIA—The Bolivian government has set up a new agency, the Mining Corporation of Bolivia, for the production and export of tin and ther metals.

CLEVELAND—The Pittsburgh Steamship Division of the United States Steel Corporation continued to break all Great Lakes iron ore shipping records in September. In one week 64 ships loaded 1,002,092 gross tons of ore. August shipments by the division were also a record, 3,974,477 gross tons.

NEW ORLEANS—Kaiser Aluminum & Chemical Corporation has placed the third of eight potlines in operation at its Chalmette refinery. Annual aluminum output from the line will be 50,000,000 pounds.

SUDBURY, ONTARIO—Two Canadian nickel companies have pooled facilities to increase output of nickel for sale to the United States' Defense Materials Procurement Agency. East Rim Nickel Mines, Limited will mine 3,500 tons of ore monthly and Falconbridge Nickel Mines, Limited will process it.

WELKOM, ORANGE FREE STATE—A large flow of water estimated at 1,400 gallons per minute has flooded the No. 2 shaft of the Free State Geduld Mines Limited here. Water rose 20 feet per hour in the 5,600 foot deep shaft.

WASHINGTON—The Defense Production Administration has announced that expansion goals and requirements for antimony, cadmium, and mercury have been met.

PITTSBURGH—The Defense Production Administration has called for a third round of aluminum expansion. It has asked for plant expansion to produce an additional 200,000 tons per year. Total expansion called for since the start of the Korean war is 670,000 annual tons. This would give United States an annual capacity of 1,700,000 tons.

CONAKRY, FRENCH GUINEA—The first shipment of bauxite has been made to Canada from Kassa Island by Bauxites du Midi. Annual shipments of 250,000 tons are planned to Aluminum, Ltd.'s Arvida, Quebec, refinery.

WASHINGTON—The Defense Production Administration has established expansion goals for beryl and barite. The goal for beryl output in 1955 is 9,000 short tons—about 4,200 short tons more than 1951 output. Barite production is to be increased to 1,360,000 short annual tons in 1955 from the 900,000 in 1951.

MEXICO CITY—The Mexican government has awarded a sulphur mining concession on Socorro Island, 369 miles off the Northwest coast of Mexico, to two Mexican citizens. Production of 200 tons of refined sulphur daily from the 95 percent ore is scheduled within a year.

MELBOURNE—The Australian government has raised the price ceiling of copper produced in Australia £65 per ton to £A350.

SANTIAGO—Production of iron ore from the Romeral deposit in Coquimbo province has begun.

Claims Court To Hear Gold Mines Case in January

Counsel for the government and counsel for all 16 gold mining company claimants who are seeking damages because of the World War II WPB order L-208 met in Washington, D.C. in October. The meeting was presided over by commissioner William Day of the United States Court of Claims.

Those present reached an agreement that the court would begin to take testimony, hear witnesses, etc., starting on January 26, 1953. It thus appears that the earliest decision the Court can make will be sometime next summer.

The Judges of the Court of Claims ruled earlier this year that three gold mining companies had the right to sue the government for damages incurred as a result of forced war-time closing of their mines. Congress later passed S. 3195 which waived the Statute of Limitations to permit other gold miners to file similar suits.

RFC Buys Accumulated Tin Concentrates from Bolivia

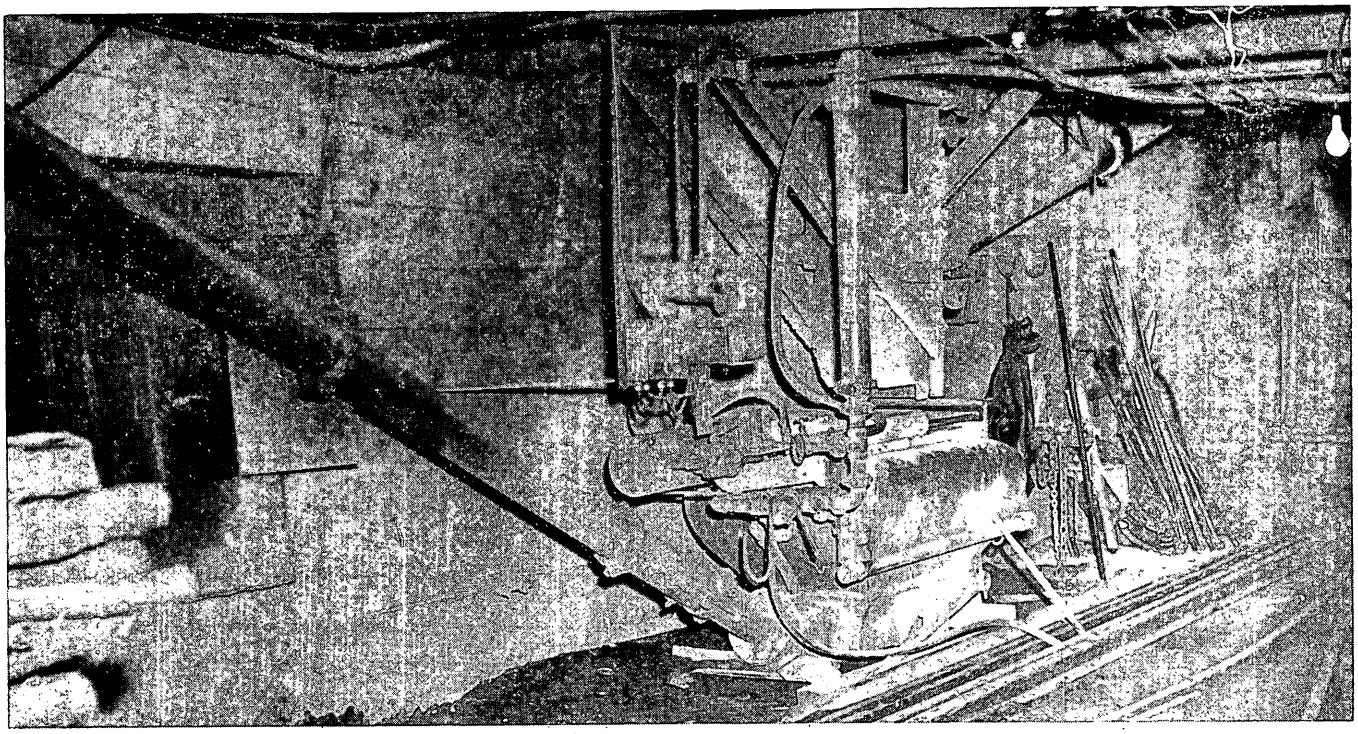
An agreement has been reached between the United States Reconstruction Finance Corporation and the Banco Minero de Bolivia (government bank) for the sale to the RFC of the present accumulation of Bolivian tin concentrates. This is estimated to be between 6,000 and 7,000 long tons of contained tin. The concentrates were sold by Banco Minero through its agent, the Mercantile Metal & Ore Corporation of New York, at a base price of $1.17½ per pound f.o.b. South American ports.

First Bauxite Shipments From French West Africa

The first shipment of bauxite ore from an important new source in French West Africa arrived in Canada last month. Aluminium, Ltd. of Canada received 9,800 tons of bauxite from its new 250,000-ton-per-year plant on the island of Kassa off the coast of French Guiana.

The plant is owned and operated by Tauxite du Midi, a French subsidiary of Aluminium, Ltd., which has been surveyng bauxite potentialities in French West Africa since the early 1920's. The Canadian firm employs more than 1,200 people at this plant and in 1950 alone invested over $2,000,000 to construct bauxite mining, drying, and shipping facilities. Construction began in 1949.

Company officials stated that the main sources of bauxite will continue to be Brazil, Jamaica, and British Guiana, but that this new plant will be a significant source of the strategic ore for Aluminum Company of Canada, its main subsidiary.



This Pressed & Welded Product Company's pneumatic concrete placer is located on the sixth level of Cleveland-Cliffs' Mather "B" iron mine 2,200 feet underground. Surface-mixed concrete enters through the diagonal pipe at upper right and is discharged through the pipe on the left which leads to the forms 2,300 feet away.

CONCRETING AT MATHER "B" MINE

The Cleveland-Cliffs Iron Company mixes concrete on surface and pumps it 4,800 feet underground for lining of slusher drifts and draw holes

Cleveland-Cliffs Iron Company is successfully mixing concrete on the surface at the Mather "B" mine at Ishpeming, Michigan and pumping it hundreds of feet down the shaft, through the sixth level, to its position behind slusher drift forms.

The town of Ishpeming is located on Michigan's Upper Peninsula and in the heart of what was at one time known as the "Great North Woods." Although the virgin woodlands have long ago been depleted, there are still thousands of acres of timber of sufficient size to be called mine timber in the immediate area. Why then, with these timber areas adjacent to the mine and readily available, does Cleveland-Cliffs turn to concrete for supporting slusher drifts.

Concrete Replaces Timber

Due to the height and nature of the ore body at the Mather "B" mine, block caving is the most economical form of ore recovery. With blocks of ore as great as 200 feet in height above the drift, it was necessary to find some supporting material that would withstand the terrific strain and shocks caused by pressure of the caving ore and blasting vibrations.

Support was originally by timber. In the words of supervisory personnel at "B" shaft: "The drifts were literally filled with timber that averaged 16 inches in diameter. By the time half the ore in a given block was removed, repair and maintenance work on the timber became excessive; while the concrete drift-lining holds up for the full time required to cave the entire block."

Pneumatic Placers

Although Cleveland-Cliffs engineers at "B" shaft recognized the advantages in concrete lining of drifts, the problem of placing concrete at a distance of nearly a mile from the surface plant was almost unsurmountable. Finally, it was decided to use three ¾-yard-capacity pneumatic placers in tandem. These units are constructed by Pressed & Welded Product Company. Subsequent experience with these placers showed management that only two were required for moving the concrete more than a distance of 4,800 feet from the mixer to the slusher drift where it was to be placed.

Concrete for drift lining is mixed in a separate plant similar to any present day, ready-mixed, concrete batch plant. Bins and weigh-hoppers were designed and constructed by personnel of the "B" shaft.

Regular portland cement is used for this concrete with some pozzolith employed as an admixture. Natural sand and gravel, obtained locally, is used in the concrete mix. The weigh-batcher, of one-yard capacity, discharges directly into a two-cubic-yard-capacity Rex mixer. The mixer is stationed under the ag-

gregate hoppers on a platform approximately four feet above ground level. When not mixing concrete for the drift lining, this mixer may be mounted on a truck to haul concrete to other surface areas of the mine as a ready-mix concrete unit.

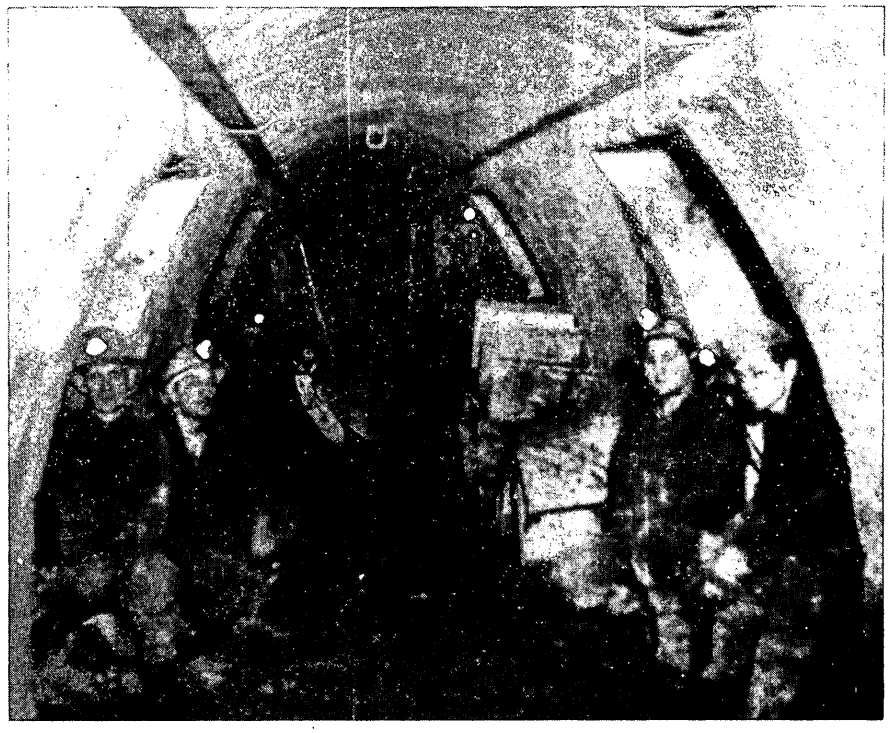
Pumped 4,800 Feet

Concrete is discharged from the surface mixing plant directly into the first placer which moves it approximately 300 feet horizontally on the surface to the collar of the shaft and roughly 2,200 feet vertically down to the sixth level. Here the second placer provides the required boost to move the concrete 2,300 feet to the drift forms. Total time required to transport a ¾-cubic-yard batch of concrete a total distance of 4,800 feet is 4½ minutes. Both placers are of ¾-cubic-yard capacity.

Collapsible Steel Forms

Minimum thickness of concrete drift lining at the Mather "B" is one foot, no reinforcing bars are used. Only forms of reinforcing used in the slusher drift concreting are two four-inch, 13-pound, H-beams imbedded in the brow of each mill hole or finger raise to protect the concrete from chunks falling during blasting operations.

Collapsible steel forms are used to hold and shape the concrete in the drifts. These forms were furnished by Blaw-Knox Company from designs drawn by the "B" shaft's engineering department. The finished, concreted drift is elliptical in shape with the bottom cut off for the poured-in-place floor. It is seven feet wide at the sill and seven feet high along the center line. In concreting a slusher drift, the floor is poured first with a slightly raised curb on each wall formed with a key-way and projecting dowels to make a bond with the walls. Steel forms are erected in the drift after the floor sets, and concrete is pumped in between the drift wall and forms.

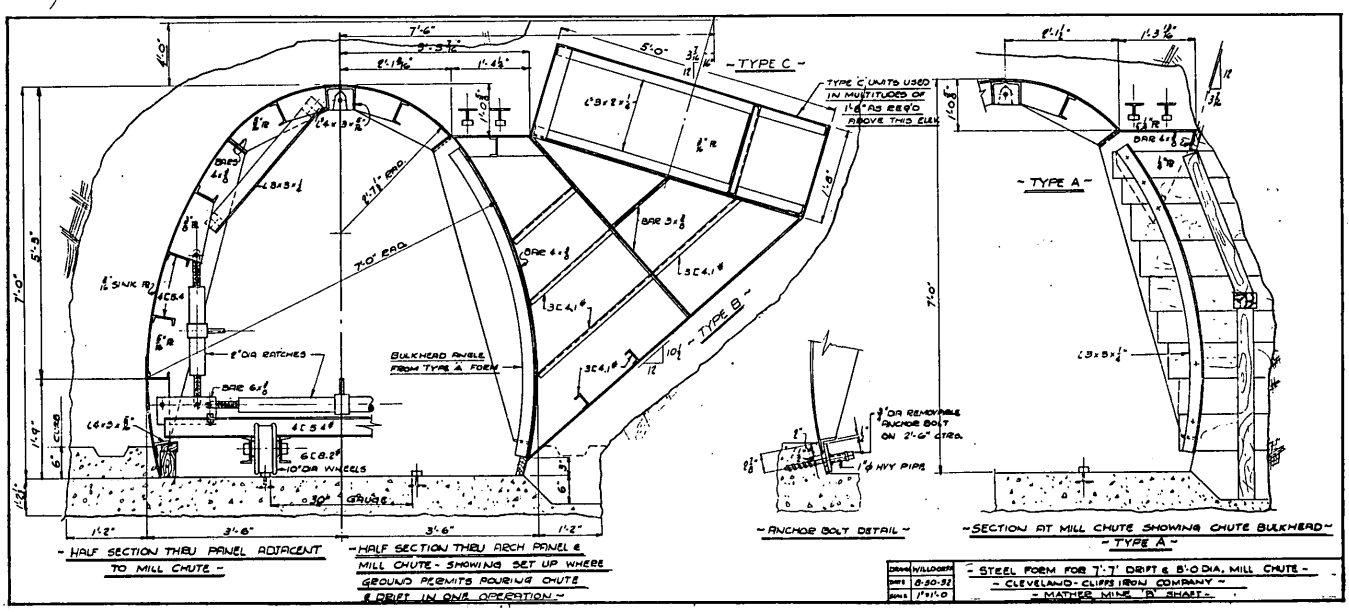


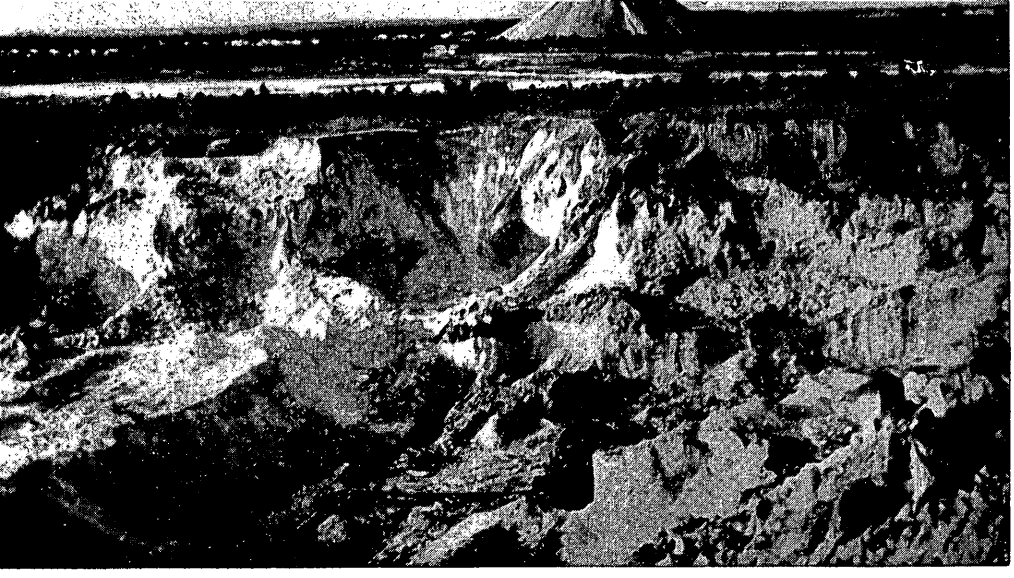
A completed section of the concrete slusher drift. Miners are in the draw points. Note the sections of the steel forms in the background and at right.

Pour 18 Feet Daily

Each form section is five feet in length and 20-foot sections are placed at one time, using four sets of forms. Each of the four sets of forms is composed of two parts, each forming half the wall from the top center line to the floor. Since two feet of overlap is allowed for each new section of concreted drift, net advance is 18 feet for each set-up of these forms. Concreting is completed one day and the forms stripped and and moved the next morning.

Mill holes or finger raises are spaced on each side of the drift directly opposite each other on 20-foot centers. The finished draw points are beautiful examples of concrete engineering. They start from the side of the elliptical drift as a square opening and at seven feet above floor elevation make a circular section.





A typical "soft pegmatite", open-pit mine at Manono, Belgian Congo. In the background is a washing plant tailing pond from another open pit.

HOW GEOMINES WILL TREAT 24,000 TONS OF "HARD" TIN ORE PER DAY

This is the first of a series of articles written by Mr. Lyons describing mining and metallurgical practices at some of the largest African mines, mills, and smelters. Data on plant operations were collected by him during a six-month, 15,000-mile automobile trip in 1951 and early 1952. He and his wife took the trip while on leave from his position as smelter superintendent for the copper smelter and electrolytic refinery of the Electrolytic Refining & Smelting Company of Australia Proprietary Ltd., Port Kembla, New South Wales, Australia. He is also a part-time lecturer in nonferrous poduction metallury at Wollongong Branch of Sydney Technical College. The photographs used with this article were taken by Mr. Lyons who is an associate of the Royal Photographic Society of Great Britain.

The current expansion of "hard pegmatite" mining and washing plant construction by GEOMINES (Compagnie Geologique et Miniere des Ingenieurs et Industriels Belges) at Manono, Belgian Congo will make this the world's largest open-pit tin lode mining operation when completed in 1953. Plans call for the mining and washing of 24,000 tons per day of low-grade primary pegmatite, from which 10,000 tons of metallic tin and important amounts of tantalite and columbite will be recovered each year.

GEOMINES will be an important tin producer for many years as reserves have been reported large enough to last for 50 years of mining.

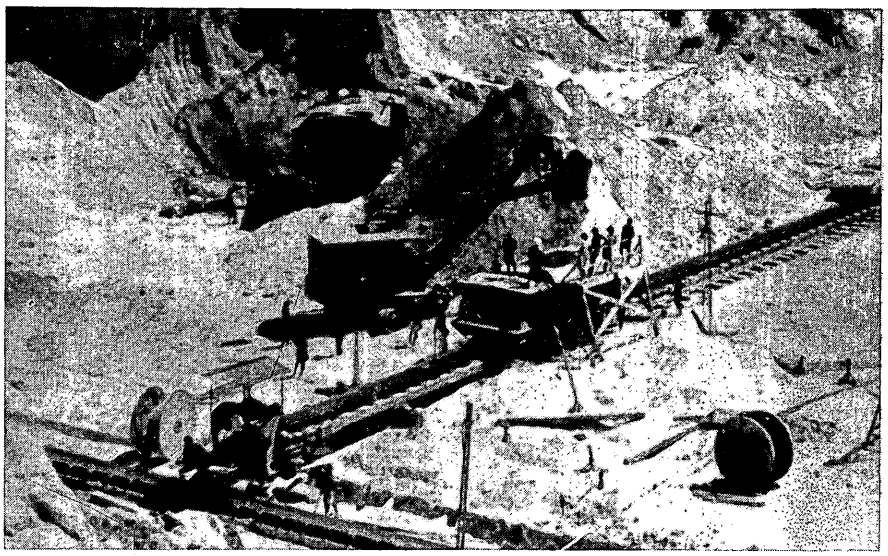
Cassiterite has been known in the area since 1912 and early production came from sluicing. Since 1933, the softer, kaolinized, near-surface "soft pegmatites" have been mined and washed. Since 1946, exploration by drilling below the soft ores at Kitotolo disclosed the existence of continuous primary ore of higher grade than the near-surface ores. This was of great significance as the harder ore is much more difficult and costly to mine and wash; in addition, it has arsenic as an impurity which complicates tin smelting.

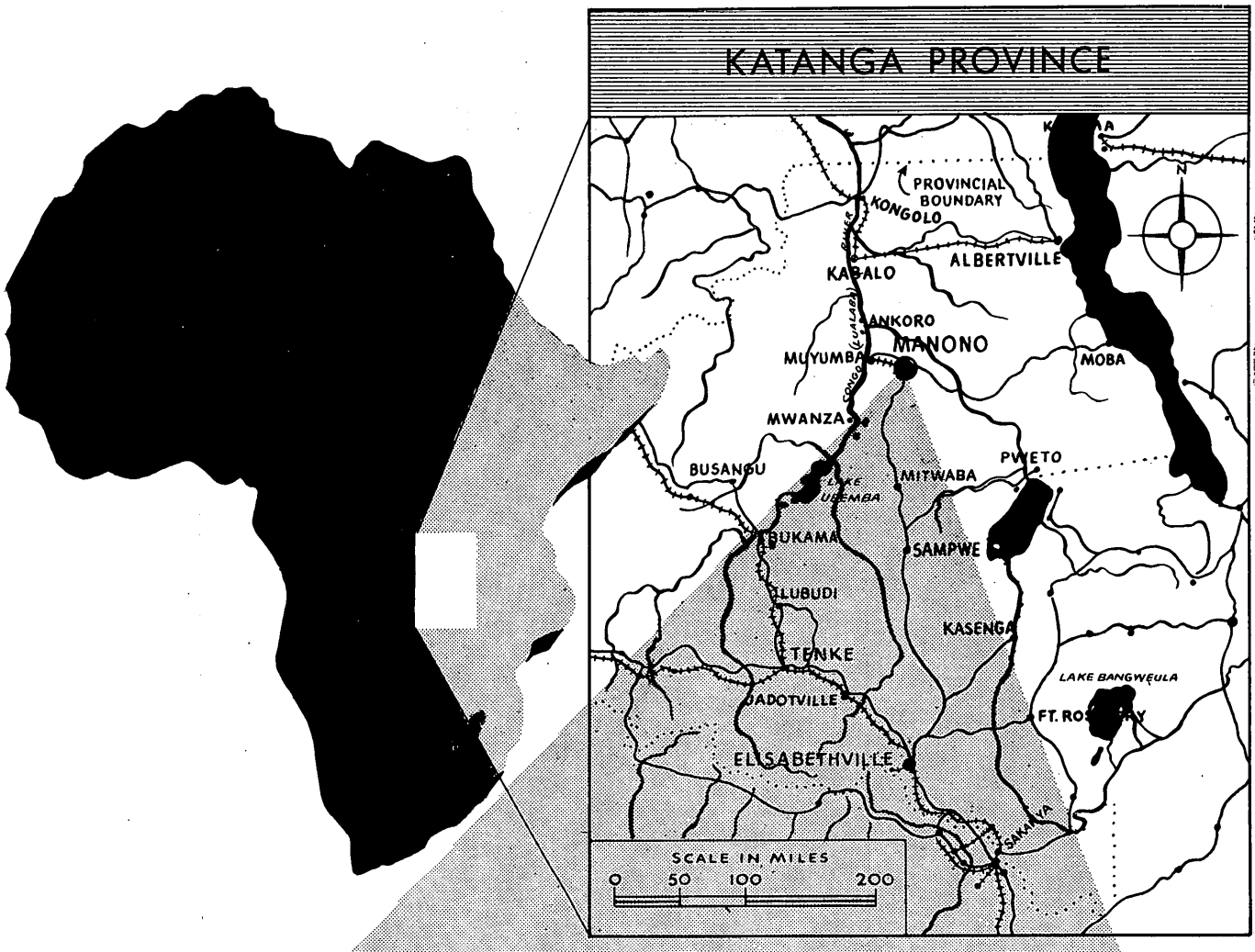
Six small washing plants (Louviere de l'est) were in operation during the time of my visit in late 1951 treating "soft pegmatite" from the Manono or easternmost pegmatite. A flow sheet of one of these is given. As the ore is depleted, these plants will become obsolete, and increased production is scheduled from the westernmost Kitotolo pegmatite.

Geology and Mineralogy

Country rock of the district is a bright, grayish schist with a steep dip. Within the schist are lenses of clear-to-dark quartzite, sometimes

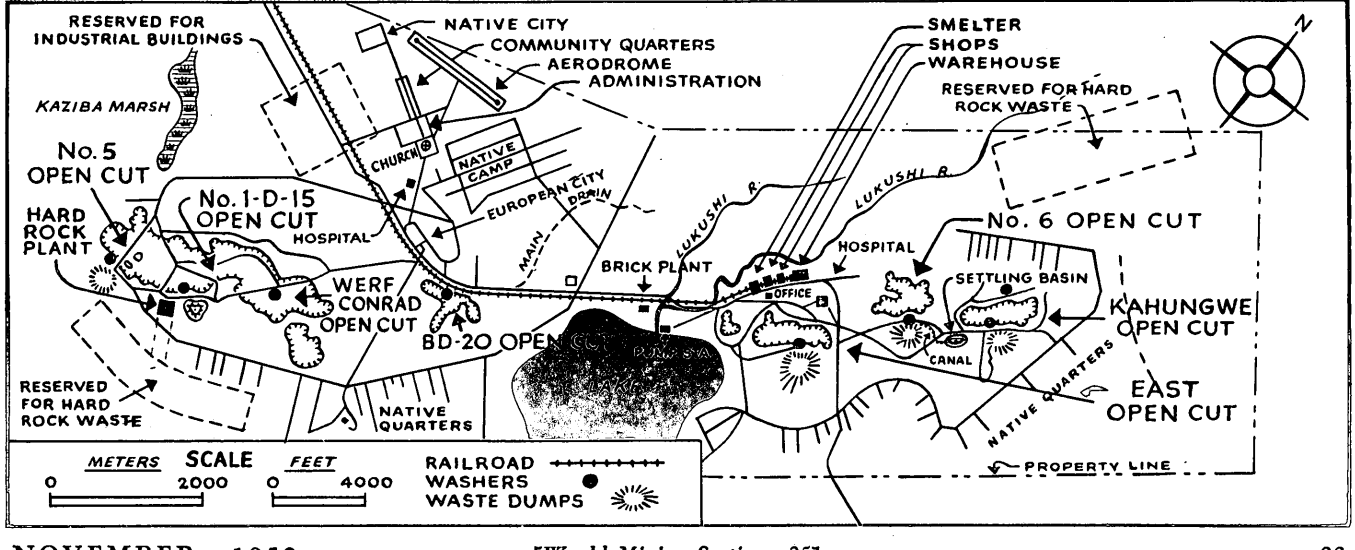
The "soft pegmatite" is dug by the large electric shovel at left and loaded onto the belt conveyor by the smaller shovel at right. Ore is elevated to the washing plant on the pit rim by the belt conveyor shown in the foreground.





THE OPEN PIT TIN MINES, WASHING PLANTS AND CAMP of *Geomines*

MANONO, BELGIAN CONGO, AFRICA



Loading tin ingots on a truck for transportation to the Lualaba (Upper Congo) River. The tin ingots are handled many times before they reach the seaports for final shipment to Belgium and the United States.

banded and hematitic, of the lower Kibara formation. Two laccolithic pegmatite bodies are found in the schist separated by about two miles of schist and granite. Each pegmatite has a general N.50°E. strike, and both are about 3½ miles long and from 150 to 2,500 feet wide. The westernmost pegmatite (Kitotolo) crops out over an area of about 1,450,000 square yards, and the easternmost (Manono) crops out over a 1,300,000-square-yard area.

Cassiterite (SnO_2) is the principal tin mineral and is disseminated almost homogeneously in the primary rock (4.5 to 5.5 pounds of tin per cubic yard). Grade is fairly uniform to a depth of 350 feet, at least. The cassiterite is found as small, black, flattened grains. A typical screen analysis of cassiterite is: Plus-10-mesh, 23.40 percent; minus-10 and plus-28, 27.90; minus-28 and plus-35, 11.60; minus-35 and plus-48, 13.10; minus-100 and plus-200, 9.40; and minus-200-mesh, 3.00 percent. In the Manono "hardrock" pegmatite, the cassiterite is not associated exclusively with the quartz, spodumene, nor in the books of mica. No tin-bearing quartz veins have been observed. Thoreaulite ($SnTa_2O_7$) has been estimated to be about five percent of the cassiterite content. Analyses of specimens, considered to be Thoreaulite, from the northern part of the Manono deposit showed as much as 17 percent Cb_2O_5. Loellingite ($FeAs_2$) is found in the primary rock and its arsenic content has caused trouble in smelting as described below. Spodumene ($LiAlSi_2O_6$) is an important constituent of the pegmatite and plans have been considered for production of lithium from it. Moisture content of the ores varies with the pit and with the season of the year. The softer ores from Kitotolo contain up to 12 percent water in the wet season and average about 6.0 percent. "Hard pegmatite" ore carries from one to three percent water.

TABLE NO. I

GEOMINES Production of Cassiterite and Metallic Tin From 1938 to 1951

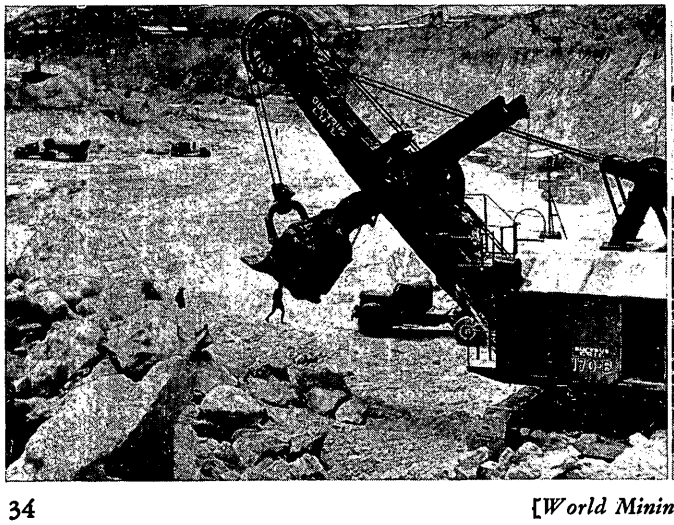
Fiscal Year Ended June 30	*Cassiterite (Metric Tons)*	*Metallic Tin (Metric Tons)*
1938-1939	3,000	2,158
1939-1940	3,772	2,753
1940-1941	5,056	3,691
1941-1942	4,860	3,543
1942-1943	4,651	3,395
1943-1944	4,436	3,238
1944-1945	4,414	3,090
1945-1946	3,770	2,639
1946-1947	3,233	2,263
1947-1948	4,050	2,835
1948-1949	5,200	3,640
1949-1950	4,650	3,250
1950-1951	3,820	2,670

Pictured at Manono outside the "hard pegmatite" washing plant are LEFT: E. Claeys, concentrator superintendent, and RIGHT: Andre Brunee, washing plant foreman.

"Hard Pegmatite" Mining

The primary pegmatite (Manono) is mined from an open pit in which a series of 75-foot-high benches have been developed. The hard rock is drilled with Bucyrus-Erie 29T and 42T electrically powered churn drills, with six- and nine-inch-diameter bits. Drilling has been a problem, but the use of nichrome steel bits has proven to be advantageous. Bits are resharpened after 375 to 450 feet of drilling. United States engineers have visited the mine to advise as to methods for improving drilling performance. Holes are bottomed five feet below grade, and are spaced 12 to 16-feet apart, 13 feet back of the top of the bank. About 1 to 1½ pounds of high-explosive gelignite powder per cubic yard is required for primary breakage. Holes are loaded with split charges with two-thirds of the powder below the intermediate stemming and one-third above. Primacord is used for detonation. The Societe Africaine d'Explosifs (Afridix) has a powder plant at Manono producing about 70 tons of powder per month for use in the "hard pegmatite" open pit. Secondary blasting is important as the rock breaks in coarse fragments which

LEFT: A general view of the Kitotolo, "hard pegmatite", open-pit tin mine of Geomines. Expansion of hard pegmatite mining is underway as the softer, near-surface, weathered pegmatites are depleted. RIGHT: This is one of the older washing plants, "Laverie de l'est", treating soft pegmatite. The flow sheet with this article is the one used by this washery.



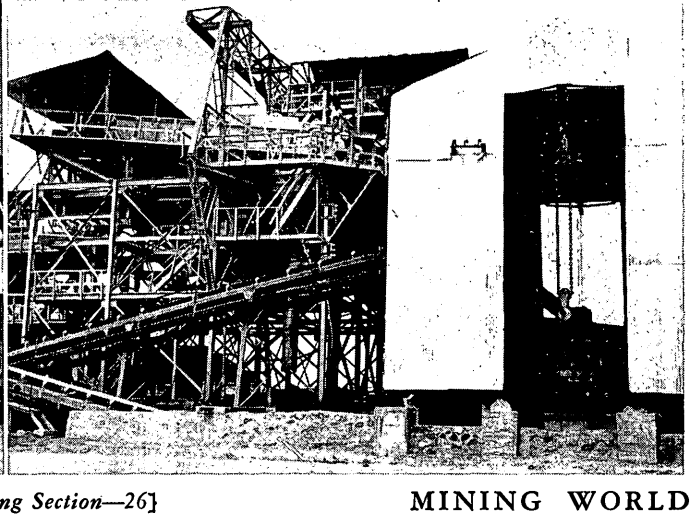


TABLE NO. II

Typical Percentage Analyses of GEOMINES' Manono "Hard Pegmatite" plant Concentrates

Constituents	*Example A Percent*	*Example B Percent*
Tin	71.20	70.10
Arsenic	0.87	1.17
Fe_2O_3	2.38	2.15
Tantalum-columbium oxides	1.79	2.85

must be block-holed with Atlas and Ingersoll-Rand jackhammers using Coromant (tungsten carbide tipped) steel. By working a long pit face this secondary blasting does not interfere with normal loading operations.

Broken ore is loaded by three, Bucyrus-Erie, 6½-cubic-yard, 170-B, electric-powered shovels. GEOMINES was the first company in the Belgian Congo to use this type of shovel, but the Union Minière du Haut-Katanga is now using similar equipment. The ore is loaded into 20-ton, Easton, side-dumping, Diesel-powered, semi-trailers and hauled to the primary bin excavated in the pit's bank. A Symons cone crusher powered by a 155-hp. electric motor and set below the rock bin crushes the ore to minus-4-inches. Crusher discharge is elevated to the 150-cubic-yard-capacity mill bin on the pit's southern bank by a 700-foot-long, 34-inch-wide belt conveyor.

The ore is grizzlied with the minus-2-inch fraction dropping to a belt conveyor and the plus-2-inch portion to two Symons cone crushers. The minus-2-inch ore is stored in six all-steel ore bins each of which has a 1,200-short-ton capacity.

Crush and Rod Mill

The recently constructed crushing plant is well-engineered, has steel framework, and is covered by corrugated aluminum sheeting which was cheaper, easier to obtain in the Congo, and has the further advantage of greater heat reflectivity than galvanized iron sheeting.

Ore from the six bins is screened over six Symons rod deck screens. The plus-⅜-inch portion going to six Symons short head crushers. Crusher discharge (minus-¼-inch) is returned to the six storage bins. Undersize (minus-⅜-inch) from the primary rod deck screens goes to six secondary rod deck screens. All minus-⅛-inch ore goes to the washing plant and the plus-⅛-inch portion to dry grinding in 11 by 9.5 foot Nordberg rod mills. Rod mill undersize is sent to the washing plant.

TABLE NO. III

Typical Percentage Analyses of GEOMINES' High-Grade, Tantalite-Columbite Concentrate

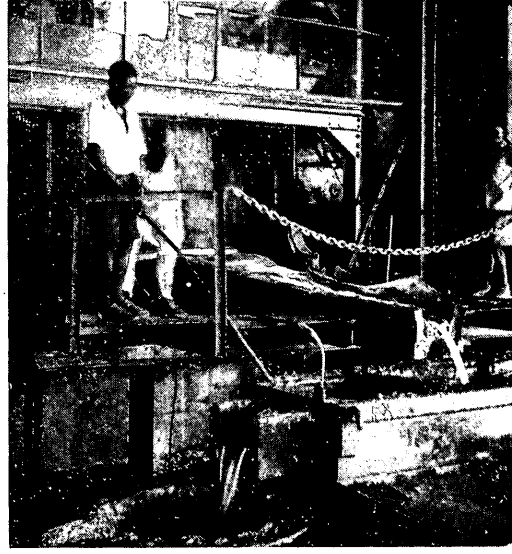
Constituent	*Example A Percent*	*Example B Percent*
Ta_2O_5	30.94	41.49
Cb_2O_5	35.29	32.37
Sn	1.91	2.22
TiO_2	1.60	0.70

Gravity Concentration

Separation of the tin-tantalite-columbite minerals from the pegmatite rock is done by gravity concentration methods as the specific gravity of the concentrate is about 7.3 and that for the rock is between 2.6 and 2.7.

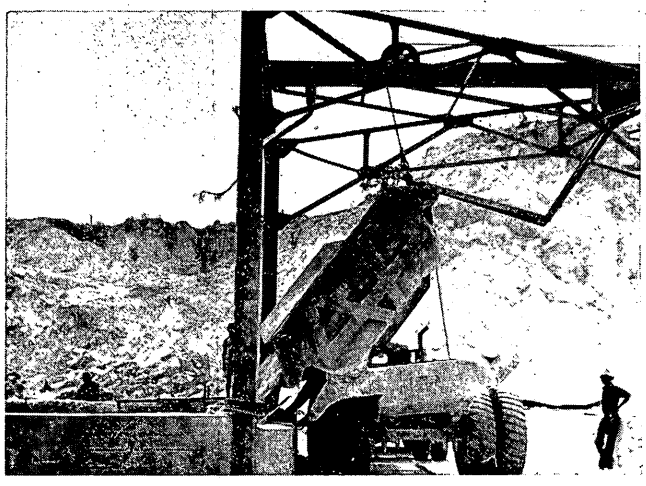
Primary concentration is by jigging in one of the six units. Each unit has a 900-short-ton capacity, all-steel, fine ore storage bin and 18 24 by 36 inch Denver jigs. The primary jig concentrate is retreated by three 24 by 36 inch Denver jigs to produce a final concentrate and a low-grade concentrate for further treatment. Primary jig tailing is passed over a 4 by 12 foot Symons screen with 12-mesh openings and the oversize discarded. The undersize plus the low-grade concentrate from the cleaner jigs is treated in a 50-foot-diameter hydroclassifier. Overflow is pumped to the head of the primary jig circuit for dilution water. Hydroclassifier underflow is pumped by four 6-inch duplex diaphragm pumps and one 10 by 8-inch Denver pump to 40 Deister tables. The tables make a finished concentrate, a middling concentrate which is recirculated, and a tailing. The tailing is decanted; the undersize goes to the tailing pile and the overflow water is reused for jigging.

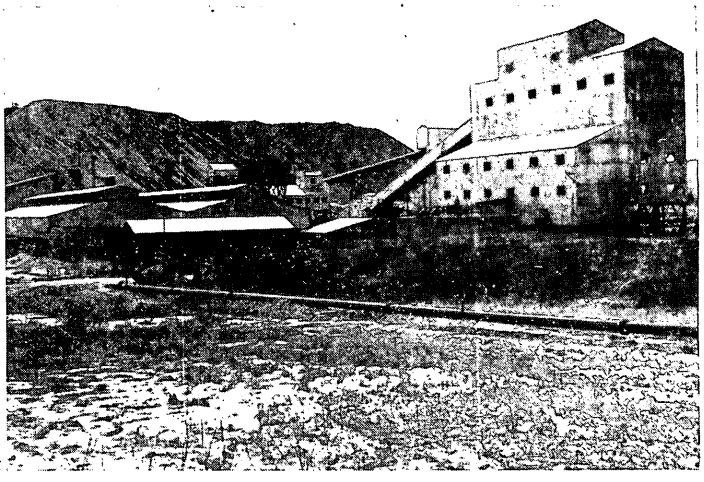
Typical analyses of concentrate from the "hard pegmatite" plant are shown in Table No. II. Most of this concentrate is shipped to Belgium for refining, and some to the United

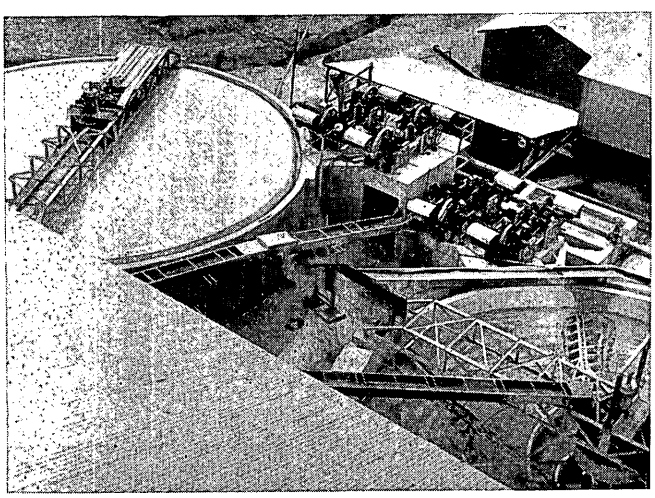


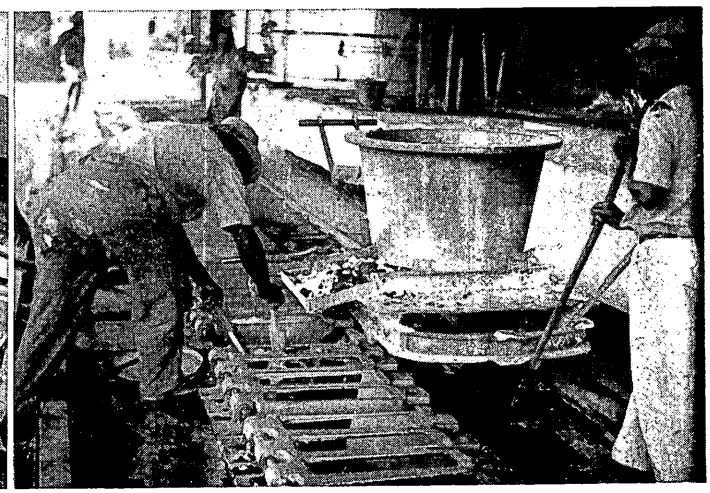
Tapping molten tin from the electric smelting furnace

LEFT: A fixed hoist is used to dump the 20-ton, Easton-body, side-dumping, Diesel-powered, semi-trailer truck into the coarse ore bin cut into the solid rock of the pit bottom. A 30-inch Symons cone crusher is set below the bin. The crushed ore is elevated to the washing plant on the pit bank by a 36-inch-wide belt conveyor. RIGHT: a view of one of the new, "hard pegmatite," gravity concentration plants. Aluminum corrugated sheets on a steel frame make a light cool building. In addition to the tin concentrate, a tantalite-columbite concentrate is also made. The large tailing pile in the background has a high spodumene content and could be an important source of lithium. Increased availability of electric power is necessary to produce lithium.









LEFT: The hydroclassifiers outside the jig-table building of the washing plant. RIGHT: Africans casting high-purity tin ingots.

States. Laboratory testing has been underway to develop a process for use at Manono based on the roasting off of arsenic, followed by magnetic separation of the tantalum-columbite oxides, and iron oxides as is now done with the low arsenic concentrate.

Tantalite-Columbite Recovery

Concentrates from the "hard" and "soft" rock washing plants are sent to a small cleaning plant near the smelter at Manono. They are separated into three fractions. The coarsest fraction is rejigged and the two smaller sizes washed on vibrating tables. The jig and table concentrates are then sun-dried in dry season or during the wet season in an oil-fired rotary drier. The tantalite-columbite oxides are removed from the dried concentrate by magmatic separation, as is the high iron portion.

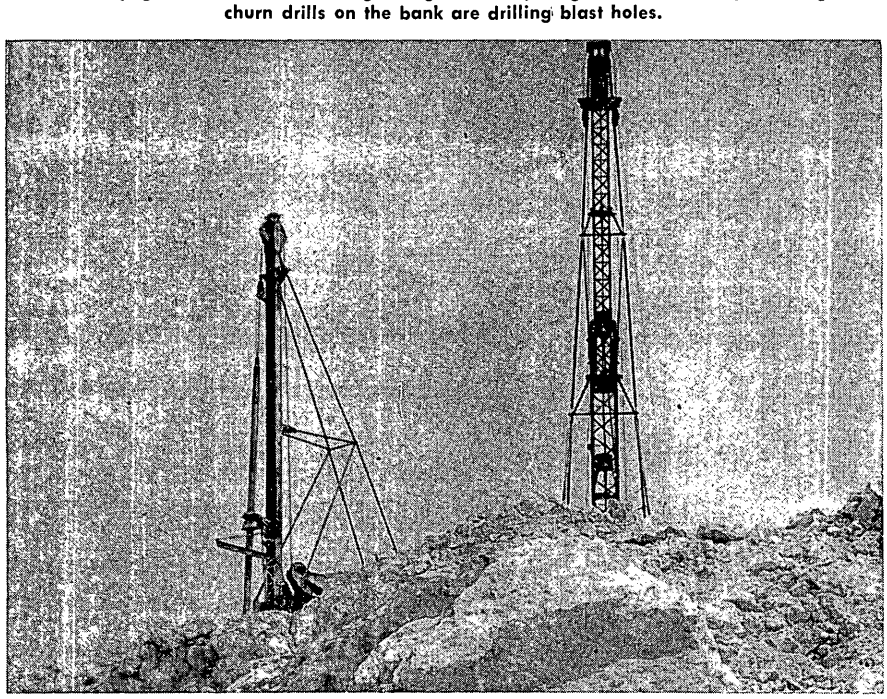
TABLE NO. IV

Typical Percentage Analyses of Refined Tin, "Rich Slag," Final Slag, and "Hardhead" at GEOMINES' Manono (Belgian Congo) Electrolytic Tin Refinery

Constituent	*Refined Tin Percent*	*Rich Slag Percent*	*Final Slag Percent*	*Hardhead Percent*
Tin	99.3	23.9	2.4	50 to 60*
Feo	—	25.1	13.7	—
CaO	—	2.2	12.9	—
Insoluble ..	—	35.5	69.6	—
Iron	0.013	—	—	—
Lead	0.005	—	—	—
Copper ...	0.0084	—	—	—
Sulphur** .	0.0015	—	—	—

* Widely variable. ** From charcoal.

The "hard pegmatite" breaks in large fragments requiring much secondary blasting. Two churn drills on the bank are drilling blast holes.



About 65 to 75 percent of the tantalite-columbite oxide is recovered in a concentrate of the grade shown in Table No. III. The remaining portion remains in the final slag from tin smelting and is shipped to the United States for further refining.

Electrolytic Smelting

The dried, low arsenic, tin concentrate (mostly from Kitotolo) is smelted with purchased concentrates (principally from Ruanda-Urundi now, but during World War II from other Congo mines) in a three-phase, 1,000-kva Siemens electric furnace. Capacity is about 1,000 tons of concentrate monthly, but recent production has been only about 350 tons. Mine production of low arsenic concentrate from the Kitotolo "soft rock" mine is the limiting factor.

Smelting of the carefully weighed and mixed charge is designed to obtain a pure tin and "rich" slag. The "rich" slag is stockpiled for two months and then retreated in a smaller (B.B.C. 850 kva) furnace. This yields "hardhead" which is resmelted with the cassiterite concentrates.

Tin from the first smelting (about 97.0 percent Sn) is liquidated at 300° C. on electric "tables" (sloping hearths). These are two inclined tables, sloping at about 16° toward a center trough, which are heated by electricity passing through a grid of high resistance wire. Each table holds two one-ton tin slabs. The liquidated tin (99.3 percent Sn) is collected in a Seigers furnace which holds 13 tons of molten tin. There it is blown for two to three hours at 400° C. After blowing, pig tin is cast in molds which are emptied by Africans.

Smelting details follow: Charge is 2,200 pounds of cassiterite concentrate, 13.2 pounds lime (burned at Manono), 440 pounds of "hardhead",

220 pounds of tin-bearing scrap, and 21 cubic feet of charcoal. Electrode consumption is 3.8 pounds per ton of concentrate. Fume loss of tin is 0.1 percent, and other losses are about 0.1 percent also. The eight-foot-deep furnace is tapped about every 2½ hours.

Water-Electric Power

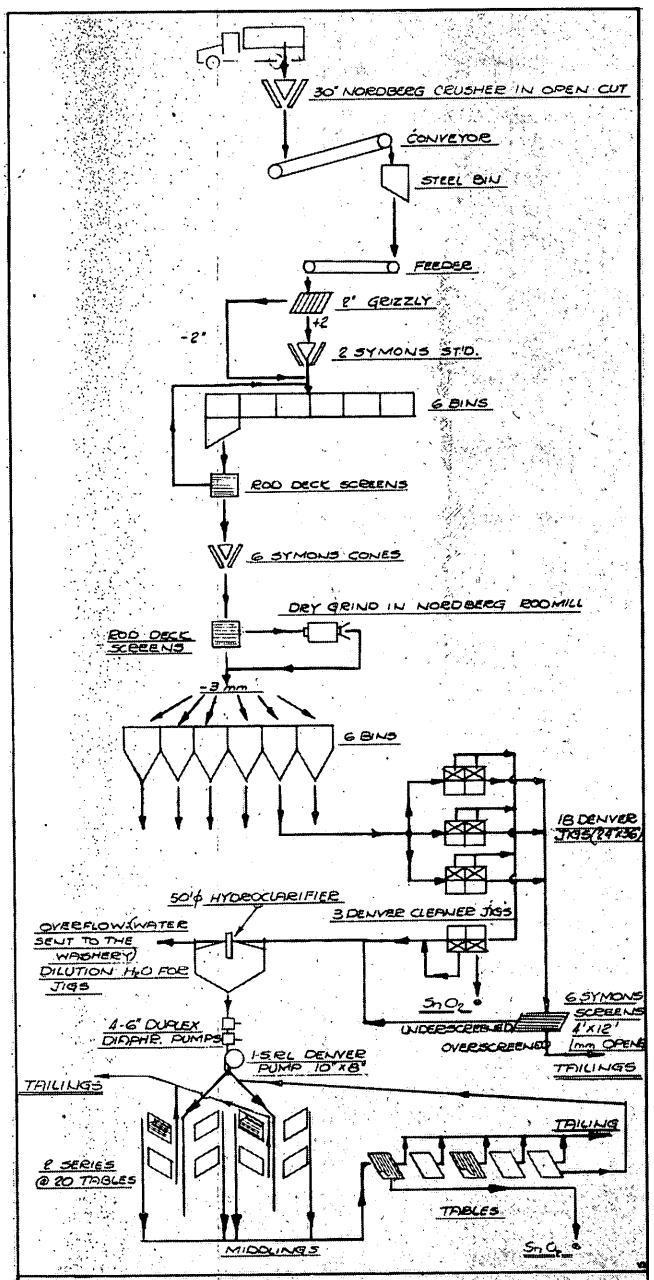
During the dry season, water for the washing plants is pumped from Lake Lukushi, an artificial lake impounded by damming the Lukushi and Luninga rivers. The company operates its own hydroelectric plant at Piana-Mwanga Falls on the Luvua River. This plant generates about 52,000,000 kwhr. of electricity per year from three generators with a combined capacity of 15,000 hp.

Future Operations

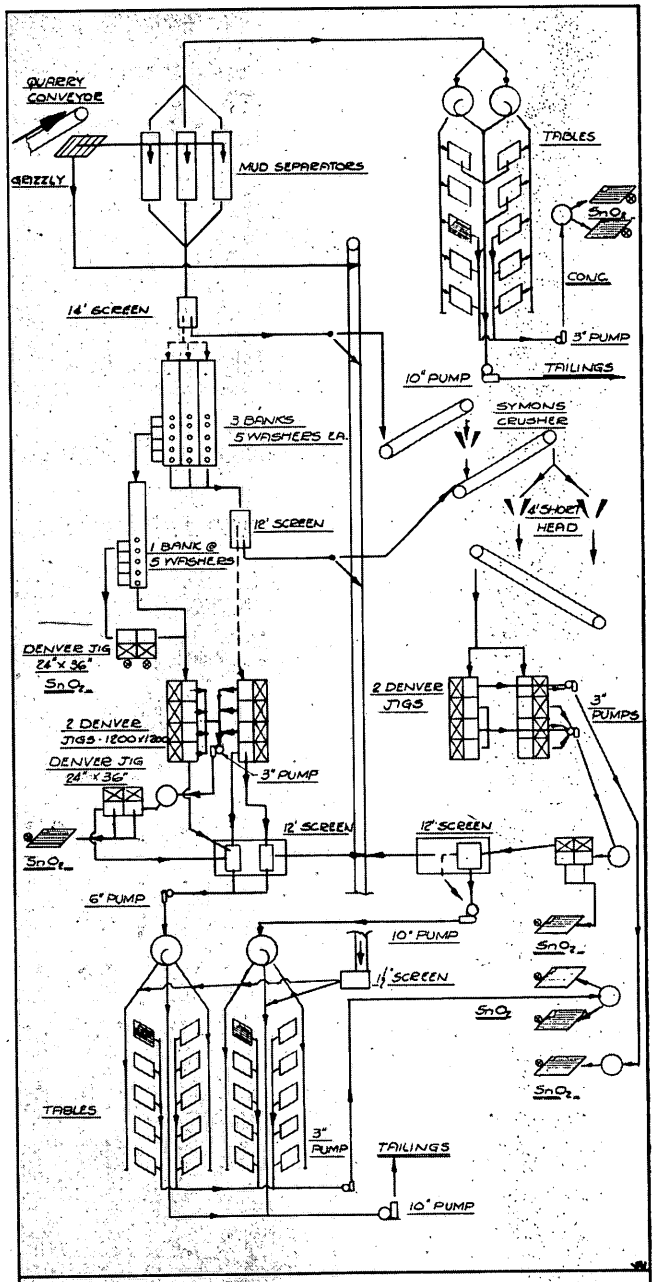
Plans have been made and actual construction is under way to increase production of "hard pegmatite" to 24,000 tons per day. Estimated annual metallic tin output at this rate of mining would be 10,000 tons.

At the increased mining rate, a total of 10 electric shovels will be required. The primary crusher in the pit floor has proven to be underpowered and two larger crushers, each driven by 325-hp. electric motors, will be used. To prevent crusher choking, a revolving chain grizzley will be installed ahead of each crusher. A new and longer conveyor belt will be installed in the pit to serve the new crusher and to shorten the truck haul. The 48-inch-wide belt will use nylon cords, and will be about 10,000 feet long. Excessive rod wear occurred in the rod mills with end feeding so the new units are to be equipped for center feeding.

The plant has successfully recovered 90 percent of the cassiterite so that the enlarged plant will have no major flowsheet changes. Additional units, similar to the equipment now used, will be added to increase capacity.



FLOWSHEET OF 'HARD PEGMATITE' WASHING PLANT OF GÉOMINES AT KITOTOLO, BELGIAN CONGO



FLOWSHEET OF LAVERIE NO VI 'SOFT PEGMATITE' TIN WASHING PLANT OF GÉOMINES AT MANONO, BELGIAN CONGO

Diamond drilling in the Treasury Tunnel of the Idarado Mining Company, Ouray County, Colorado.

Christensen Diamond Products Co. Photograph

DRILLING TIPS FOR DIAMOND BITS

The correct size of the right type of diamond set in a properly designed bit to drill a specific rock will increase drilling speed at lower cost

By Burton J. Westman

Consulting mining geologist
Aloha, Oregon

Rotary drilling with abrasives is probably the oldest method of boring known. The Egyptians used this method to bore true holes through the Pyramids from the vaults beneath, so positioned that a known astronomical observation is visible but once a year. The actual drilling method the Egyptians used is still a mystery.

What was below the surface of the earth has been a quest of man for centuries, and the mining fraternity always has had its own big problem making holes, particularly making them deep and fast. The first step over slow hand drilling was made during the boring of the Mt. Cenis tunnel between Italy and France during the 1860's. Robert Leschott, a Swiss engineer, reflecting on how the Egyptians bored through the Pyramids, and how jewelers were boring small holes through precious stones, developed a column-mounted, hand-operated gear device to rotate a hollow rod tipped with a hand-set diamond bit. This was an immediate success, and the headings on both sides were advanced rapidly from then on. During this same time on the Mother Lode in California, one reference is made to a similar operation with diamond-tipped rods. Little came of the latter, however, because it wasn't until the 1880's that the diamond drill as we know it was brought to the United States for exploration work in the Tri-State region.

Diamond drilling for cores continued, but using it for blast hole drilling was superceded by the steam, then the air percussion drill.

In the 1930's blast hole drilling was again resurrected experimentally in Europe (particularly in Sweden), perfected, and brought back across the Atlantic where it has been used extensively in the United States and Canada up to the present for long hole blasting in mining and construction.

Until about 10 years ago, diamond drilling of blast holes deeper than 18 feet was more economical than percussion drilling with pneumatic hammers; however, since World War II, the rise in diamond cost has brought about the development of long blast hole pneumatic drilling using carbide bits, which, in some mining districts, notably Howe

About the Author

Born in the Iron River mining district at Stambaugh, Michigan, the author became interested in diamond drilling as a youth. Since then he has had a wide variety of experience in drilling, equipment design and drilling application. His greatest interest in core drilling is in the factors involved in core loss, which resulted in his discovery of the "calyx packing" phenomenon among other overlooked causes. The author also believes that diamond drilling can be applied to large diameter bore holes for rapid shaft sinking and is currently developing material for a paper on this subject.

Mr. Westman is a graduate of Michigan State College and a World War II veteran. He is a consulting mining geologist with headquarters at Aloha, Oregon.

Sound Mining Company's Holden, Washington, mine has now superceded diamond drilling.

Drilling Large Holes

The need for both large and very deep holes during the past two decades in the construction and mining fields has lead to several developments. The use of diamonds here was bypassed by other methods. Reaming pilot churn drill holes out to 30 and 48 inches has been done down to 500 feet, but the greatest development was with calyx equipment. This method, using chilled steel shot as the cutting medium, has been used to bore up to 66-inch diameter holes to 1,208- and 2,487-foot depths. The slowness of penetration of this latter method has resulted in excessive labor cost, so at present, there is some investigation into the possible use of diamonds to speed up the penetration. At present one 48-inch diamond drilling program is contemplated for 1952 on an experimental basis. The largest diamond drill holes to date are two 38-foot horizontal bores drilled by Canadian Longyear Ltd. on the Isle Maligne dam construction.

Holes By "Structural Drilling"

Another method is an old one used long before the turn of this century. It is called jetting or wash boring. Much of this was done in the Lake Superior Region between 1880 and 1900 to probe for iron ore beneath the thick glacial overburden. This method employs only water conducted down through a small wash pipe, which is churned up and down through pipe casing, and the broken material is washed to the surface. Since 1930 this method has been improved on the Mesabi Iron Range, and is now termed "structural drilling."

However, instead of a wash pipe with or without a chisel or fish-tail bit, structure drilling employs a heavy flush-joint hollow drill rod at the end of which is a hollow chopping bit set with tungsten carbide teeth similar to those used on pneumatic drill bits. This drill rod is chopped up and down in the usual manner through casing. But, instead of water being forced down the wash pipe, it is forced by means of a packing gland casing head to travel between the rod and the casing down to the chopping bit to carry the cuttings up inside the drill rod.

One big advantage is the greater clearance inside the drill rod which enables large fragments of formations, even short sections of core, to be washed to the surface, hence reducing the drilling time.

Other advantages are that, being used with a standard diamond drilling rig, the bit can be rotated through softer formations, chopped through broken hard rock that ruins diamond bits, and, in very hard, solid formation, the usual diamond drilling procedure may be employed. Here then, is one of the best all-around drilling methods for shallow drill holes, although it is limited to angles less than 45 degrees from the vertical.

In discussing diamond drilling, much could be gained by the engineer engaged in construction, foundations, or mineral exploration where the diamond drill is employed, if he more fully understands the limitations of the diamond drill, the type of diamond most suitable, and the type of bit most applicable.

Diamond Data

The diamond itself is more or less taken for granted. Prior to 1930, diamond bits were hand set by peening large Brazilian carbonados into holes drilled in the bit crown; but due to the rise in their cost, machanical setting of the far cheaper or more plentiful African stones was developed.

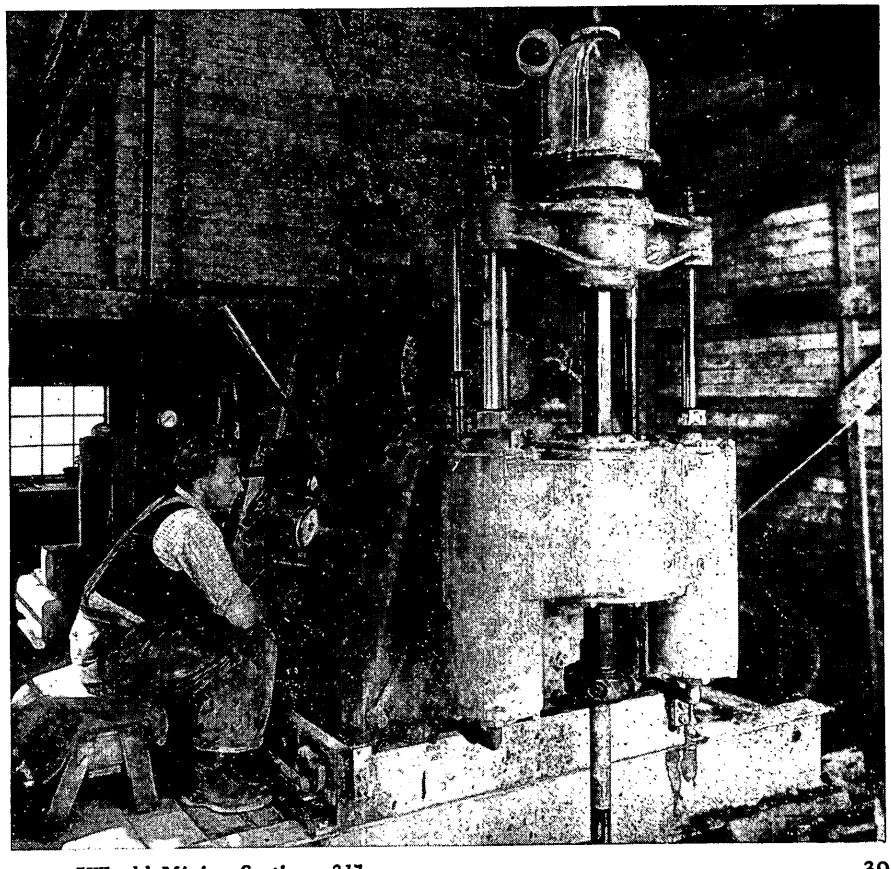
1. The Brazilian carbonado, which is a compact, opaque, black to grey stone without cleavage, and ranges from 2.75 to 3.50 in specific gravity. The lower gravity stones are very porous, and hence, softer. The higher gravity stones are more dense but somewhat brittle and therefore cannot withstand as much shock. Shrewd buyers try to select those stones ranging between 3.30 and 3.35 in specific gravity. Cost per carat ranges from $35.00 to $120.00 depending upon color, specific grav-

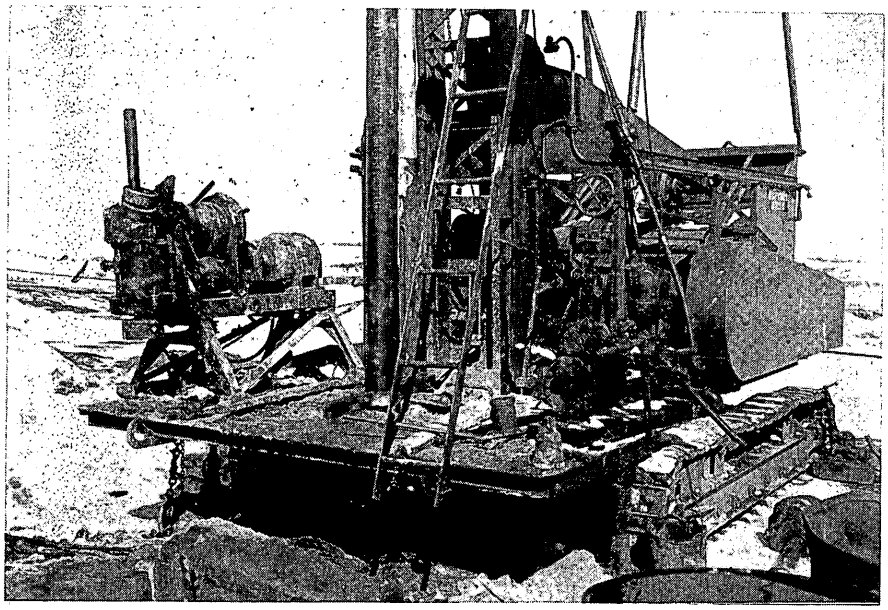
Experienced Diamond Drillers Recommend:

- —"Structural drilling" for alluvium or unconsolidated overburden.
- —West African bort for coarse grained, medium hard, tough rock.
- —Congo bort for fine grained, very hard, tough rock.
- —Diamond chips cast in powdered metal for fractured ground.
- —Brazilian carbonados in a hand-set bit for extremely hard, fractured, siliceous rock.
- —Stones of two to 12 per carat for soft rocks, 12 to 24 per carat for medium hard rocks, up to 90 per carat for dense, very fine grained hard rocks.
- —Double core barrels for higher core recovery.
- —Detailed records for cost accounting.

A heavy-duty Swedish hydraulic-feed diamond drill.

Swedish Diamond Rock Drill Company Photograph





A platform mounted diamond drill and churn drill combination used on the Mesabi Range.

ity, mine-run or (broken) into suitable sizes. The stones are broken into somewhat cubic pieces of 2.0 or 4.0 carats (wasting up to 25% in the process), then set into drilling bits. Used, rounded stones have toughened and are at a premium.

2. West African stones or bort are the imperfect diamonds, resulting from the gem mining industry, and account for some 95 percent of the production by weight. These crystallize in the cubic system, and are generally colored yellow, red, green, blue, brown and black. These are the hardest diamonds of all, but are brittle due to the perfect cleavage. They range in size from 100 or more per carat to several carats in size. The better quality is used for other industrial purposes. Three general qualities of drilling bort are A, AA, and AAA, ranging in price from $4.00 to $12.00 per carat.
3. The Congo diamond is similar to the West African, but is generally rounded by an opaque coating that precludes classification. These stones run in the same size range, but are tougher than the West African. The cost is between $4.00 and $7.00 per carat. Prior to 1940 this diamond was considered inferior, but due to the demand for diamonds (the United States used almost 1,000,000 carats of industrial diamonds a month during War II), Congos were resorted to and were found to be satisfactory. Since 1945, the drilling industry, largely through U. S. Bureau of Mines experiments, has obtained better results from them than the A or AA West African bort. This probably has been known before because most of the Congos smaller than 10 per carat are difficult to obtain. One California company, however, has set Congos for many years with excellent results.

The diamond output is controlled quite rigidly, although considerable smuggling has been going on in recent years. Prior to 1930 "crushing" bort was obtainable for about $1.00 per carat, and hardly doubled in price up until 1940.

Cast-Set Bit Development

Diamond drilling was seriously curtailed by 1930 as a result of the high price of Brazilian carbonados, then sold for more than $175.00 per carat. This was fortunate, however, because it stimulated experiments with cheap West African diamonds. Hand-setting them like carbonados was an extremely delicate operation because they couldn't withstand the shock of overpeening but such bits were used successfully at Hoover Dam, resulting in a great reduction in drilling costs. Mechanically set bits gave better results and soon cast-set bits were in production. Experiments were also being conducted to set diamonds in powdered metal. The big drawback, however, was the lack of control over shrinkage that resulted in defects in the crown. This was overcome, at first, by pressing strips which were then brazed into radial slots in the core bit crown. As powder metallurgy progressed, shrinkage was overcome, so that by 1940, all types of drilling bit crowns were being manufactured directly onto bit blanks. The toughness of the cast copper-beryllium alloy matrix was increased by adding nickel and chromium, thereby increasing the abrasion resistance and increasing the bit life in very abrasive ground. The powder-metal bits went further by developing matrices consisting essentially of powdered tungsten carbide bonded with copper or, better, nickel-silver for the highest abrasion resistance. The primary concern was to create a firm bond to the diamond in a prepatterned position.

The choice of matrix is generally governed by the type of ground to be drilled. If it is only mildly abrasive, a cast bit is preferred; if very abrasive, a nickel-silver bonded tungsten carbide bit is in order. The resistance of the matrix, however, should not exceed the cutting life of the diamond, otherwise a higher setting cost would be wasted.

The diamonds that are used in bits should be carefully selected in

Accepted Standards For "X" Series Diamond Drilling Equipment Measured in Inches

Equipment	*Tolerance**	*EX Size* OD**	*EX Size* ID***	*AX Size* OD	*AX Size* ID	*BX Size* OD	*BX Size* ID	*NX Size* OD	*NX Size* ID
FOR CORE BARREL									
Bit blank	0.002	1.430	0.875	1.835	1.218	2.300	1.687	2.915	2.187
Set bit	0.005	1.460	0.845	1.865	1.185	2.330	1.655	2.945	2.155
Reaming shell blank	0.002	1.430		1.835		2.300		2.915	
Set reaming shell	0.005	1.485		1.890		2.360		2.980	
FOR CASING									
Bit blank	0.002	1.830	1.437	2.295	1.812	2.910	2.250	3.560	2.875
Set bit	0.005	1.865	1.405	2.330	1.780	2.945	2.215	3.595	2.840
Reaming shell blank	0.002	1.830		2.295		2.910		3.560	
Set reaming shell	0.005	1.890		2.360		2.980		3.630	
Shoe bit blank	0.002	1.830	1.505	2.295	1.910	2.910	2.380	3.560	3.000
Set shoe bit	0.005	1.865	1.500	2.330	1.905	2.945	2.375	3.595	2.995
FLUSH JOINTS AND COUPLINGS									
Flush joint casing	0.002	1.812		2.250		2.875		3.500	
Flush coupled casing	0.002	1.812	1.625	2.250	2 000	2.875	2.469	3.500	3.063
Casing coupling	0.002	1.812	1.500	2.250	1.906	2.875	2.375	3.500	3.000
Flush joint drill rod			(Canadian XRT size; not mfg. in U.S.A.)						
Flush coupled drill rod	0.005	$1\frac{15}{16}$	$\frac{37}{32}$	$1\frac{5}{8}$	$1\frac{17}{64}$	$1\frac{29}{32}$	$1\frac{19}{32}$	$2\frac{3}{8}$	2
Drill rod coupling		$1\frac{15}{16}$	$\frac{7}{16}$	$1\frac{5}{8}$	$\frac{9}{16}$	$1\frac{29}{32}$	$\frac{5}{8}$	$2\frac{3}{8}$	1

* Tolerances are plus or minus. ** Outside diameter. *** Inside diameter.

size and grade although much hocus-pocus still surrounds some quarters of the manufacturing industry, with the user generally getting little factual information about the actual quality he gets to use. It is the author's opinion that good, used diamonds are preferable to new, untried stones because the inferior stones are destroyed in a new bit, while the used stones returned for resetting have been subjected to and have withstood punishment and therefore are the better for it.

Diamond Salvage Facts

Many large users of diamond bits practice removal of the diamonds from used bits in their own laboratories. This is a good practice because it prevents getting inferior grades into the bits. It also eliminates the opportunity for the manufacturer to "scrap" a certain percentage of resettable diamonds in order to sell more new diamonds to bring the reset bit up to proper carat weight. The profit by the manufacturer is in the diamonds he sells more so than in the setting of them into bits; therefore, certain practices could be guarded against. Certain bit manufacturers sell only new diamonds in their bits and add only new diamonds to the resettable bits as are needed. But, at the end of the exploration program, when the salvagable bits are to be reclaimed, the still usable diamonds will be bought back at scrap price, usually, at $1.00 to $1.50 per carat. Other concerns have a more equitable policy of buying back all usable diamonds at the original selling price and either giving credit for the scrap and charging for the reclaim, or keeping the scrap for the cost of reclaiming the bit.

All bits should have the exact carat weight stamped on the bit shank as well as the bit number; this information is recorded before the bits are used. Later the reclaim data will give accurate bit costs. Where doubt exists, a random bit from the factory should be reclaimed before use to determine whether the quantity and quality of diamonds check with that stated on the invoice.

Pick Stones And Bits For Rock

For most types of drilling ground, the AA West African or round Congo diamonds will give satisfactory results; the use of A quality West African stones generally results in higher diamond loss, and therefore, higher bit costs. The use of AAA (round and semi-round) West African bort should be limited to very tough drilling conditions.

W. A. Richelsen Photograph

A NX diamond core drill on a Wyoming sulphur exploration project. The air powered drill is mounted on a column screwed into a nipple and cemented into the solid rock. Note the stay bolt and turnbuckle used to take up slack.

Where West African stones take on a rapid polish the Congo set bit should be substituted because the Congo will not take on a non-cutting polish as quickly as the West African diamond will in very fine-grained, hard rock. Where very broken, hard rock is being drilled, a powder metal bit impregnated with coarse diamond chips often gives very economical results, especially if the matrix is chosen to abrade only slightly faster than the wear rate of the diamond particles. In non-abrasive ground these bits tend to polish and burn, however, requiring repeated sand-blasting to expose the cutting diamonds. This type of bit is used until the crown has been consumed. Where extremely hard, broken, siliceous rock is being drilled, such as those pre-Cambrian formations encountered in the Lake Superior iron districts, the old hand-set Brazilian carbonado bit still gives better results and lower costs than the best of mechanical set bort bits.

In general, the weight of diamonds used in a bit should run about 8.00 carats West African or 10.00 carats Congo per square inch of projected bit crown and the size of stones generally should be two to four per carat for the softest rock and up to 12 or 14 per carat for soft but firm rock. These would include chalk, siltstones, softer shales and shaley sandstones. Usually, granular rock or those that make coarse sludge require the large diamonds for more efficient drilling. These sizes can be either West African or Congo. For harder rocks, the smaller diamonds are employed for better results. Twelve to 24 per carat should be used for medium hard rocks such as fine-grained sandstones, limestones, dolomites and greenstones. Up to 90 per carat for dense, very fine-grained hard rocks such as granites, quartzites, silicified dolomites, cherts, and jaspers may be used. If the West African diamond tends to polish, use either the Congo diamond or the impregnated bit.

For various broken rocks, especially the harder, silicified types, the manufacturers recommend many small high-quality diamonds or impregnated bits. Broken rock can never be satisfactorily drilled without very high bit costs and if hand-set carbonados are not available, then the broken section should be chopped through with a chisel bit or a hollow structural bit wherever possible. Many coring projects have attempted to core broken rock without much successs; chopping would have been more economical and would have resulted in just as much information.

Recently, as the result of U.S. Bureau of Mines experiments, great strides have been made in setting diamonds to present their maximum-wear hardness vector, resulting in greater footages and longer bit life than possible by non-orientation as practiced by commercial bit manufacturers.

Diamond Sizes

The number of diamonds per carat recommended above are only approximate in that manufacturers' bits are made in certain ranges. The higher quality diamonds are more dense; hence, there are fewer stones per carat. Listed below are the aver-

This is a Wheel Trueing Tool Company Truco "EX" pilot bit after drilling 26,722 feet for the Warner Company at Bellefonte, Pennsylvania. The original 14.16 carats of diamonds had worn to a weight of 9.65 carats.

age number of stones per carat for various sizes:

Screen No.	*Stones per Carat*
1	55-65
2	45-55
3	35-45
4	27-32
5	20-24
6	15-18
7	12-14
8	9-11
9	8-9
10	6-7
12	4
14	3
18	2
22	1

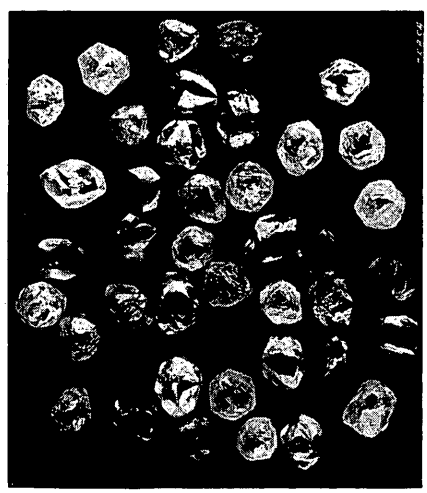
In order to select the diamond size most suitable for the formations to be drilled, an understanding of the character of the rock is most helpful. Little has been published on the action of diamonds; the author contributed some study and thought on this subject in "Mud Flow Through Oil Field Diamond Core Bits"[1]; and also in a discussion on "Diamond Drilling Quartz-Feldspar Intergrowths."[2] The former mentions diamonds acting like a multiple drag bit and wear by frictional skin heat, causing spalling and surface oxidation of the diamond; the latter covers diamond contact area and "point force," penetration and possible means of avoiding non-cutting polish.

With the ever-increasing need for core drilling both in mining and construction work, the stress is on better core recovery. Here there are widely divergent opinions on the type of core barrels that will give the desired results. Recently the development of a double tube core barrel wherein the inner tube contains a tapered case within which the core lifter rides, has been a marked improvement over the standard barrel with its bevel-wall core bit, where small fragments of core wedging between the taper and the core is responsible for much of the core blocking, core scouring and breakage, as well as for much of the rod snapping heard on the surface.

Barrels For High Core Recovery

This new barrel is called the M-Series and has become increasingly popular due to its high core recovery. A few years ago, the author was responsible for the revised specifications of the M-Series core lifters, and also for a new type of lifter with external ribs and carbide chips fused to the inside in strips, which was used by the U. S. Bureau of Mines with excellent results. The basis for its design was to create high friction against the core without resorting to high compression and also to create a minimum external friction for immediate positive seating to prevent core slippage.

The one drawback of the M-Series core barrels is the weakness of the



AAA West African drilling diamonds.

necessarily thin outer barrel wall and the frail threads. To lessen this, the heavier L-Series barrel was developed, wherein the core lifter case, instead of being threaded, is held onto the inner tube only by slip fit. On recovering core, the stress is not on the inner tube but is transmitted onto the outer tube. This L-Series barrel also has a much shorter bit eliminating the higher setting cost of the tube-like M-Series bit. The L-Series barrel also has other advantages. The lifter case can be replaced by a straight-wall inner tube extension so that coring may be done in the same manner as one would with a double tube barrel and a straight wall bit. This method is preferred in many sections, particularly in Canada. A bevel-wall bit and lifter can also be used by substituting a reaming shell in place of the L-Series bit.

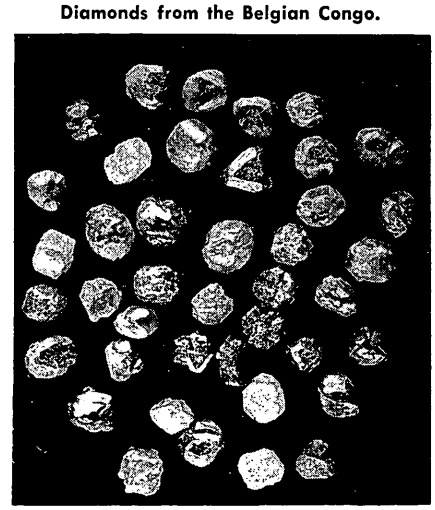
Regarding core barrels in general, the larger the size the better core recovery is usually. In jointed rocks, however, using a barrel size that will accommodate the longest core proportionate to the joint spacing can result in better recovery and longer core runs. In badly broken rock, a straight wall bit on a swivel-type double tube barrel will recover more core than a bevel bit because the lifter and the wedging of rock fragments in the bit taper tend to destroy core and cause core blocks. Dry blocking with a straight wall bit to recover core, unless done very carefully, will result in higher diamond loss as a result of burning, especially in fine-grained hard rock. The M-Series and the L-Series barrels seem to have struck a medium between bevel and straight wall bit coring and their use should be investigated when other types have given too erratic runs and poor core recovery.

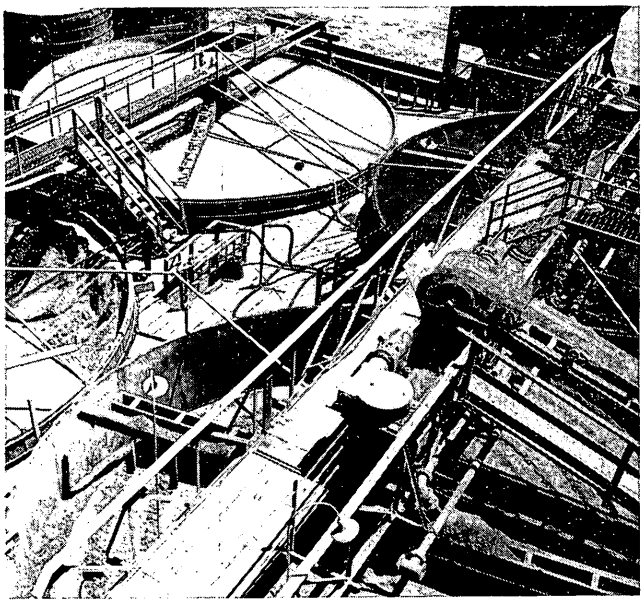
Records For Cost Cutting

With so much coring being done on company account, the engineer in charge should do everything possible to increase core recovery and reduce diamond consumption. This can be done by keeping detailed records of bits used and the results obtained, then studying these results. One big drawback, however, is the lack of complete drilling records on the part of the drill runners. There is a great need for an automatic drilling time recorder such as is in use on oil field drilling rigs. This instrument could be adapted to record penetration time by fractions of a foot instead of by the foot as used in oil field practice; it would also keep accurate record of actual drilling time, down time, and time spent pulling rods. With this information the engineer could keep an accurate tab on the performance and efficiency of both crew and equipment.

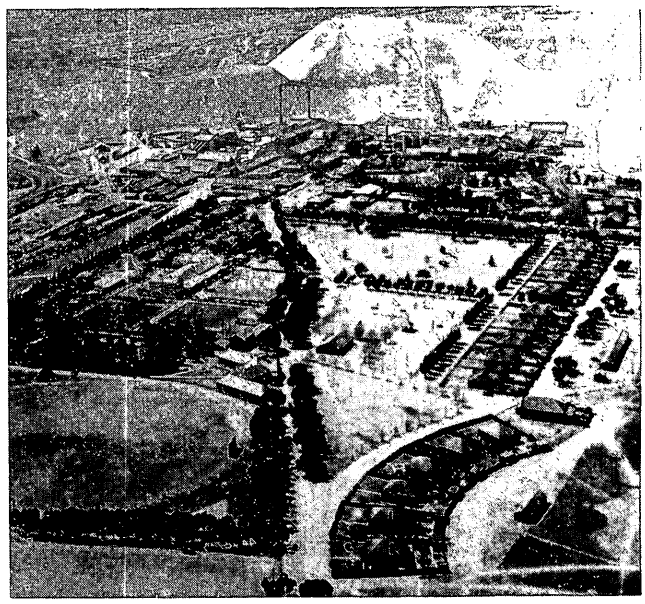
1. *Journal of Petroleum Technology*, Section 1, July 1950, pp. 8-9.
2. L. C. Armstrong, *Mining Engineering*, June 1949. *Transactions AIME*, vol. 187, p. 1148.

Diamonds from the Belgian Congo.





COLORADO



SOUTH AFRICA

New Mills and World-Wide Ore Discoveries Insure Uranium Adequacy For Hydrogen Bomb

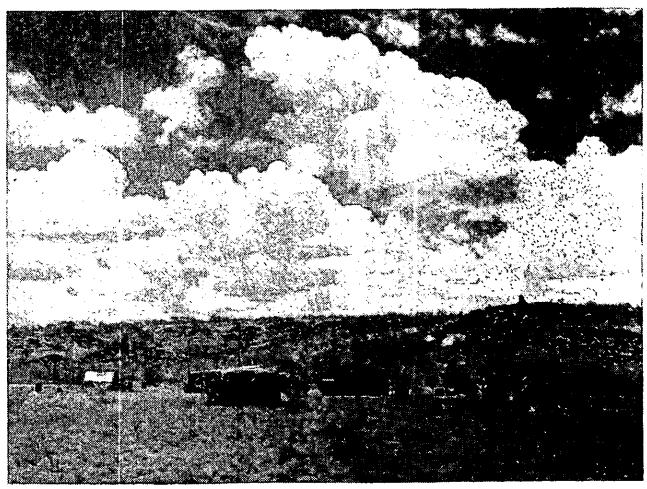
COLORADO—The United States Vanadium Company, the largest producer of uranium in the United States, has just put its new two-roaster, high-lime uranium plant into operation at its Uravan, Colorado, plant. The new plant will treat carnotite-type, uranium-vanadium ores from the Colorado Plateau. Heretofore, only a limited amount of high lime ore was mined and milled because of the metallurgical difficulties in recovering uranium.

SOUTH AFRICA—First commercial production of by-product uranium from the gold mines of the Witwatersrand has been made at the new slime treatment plant of the West Rand Consolidated Mines, Ltd. at Krugersdorp, Transvaal, Union of South Africa. The $4,500,000 by-product plant, construction of which was started in early 1951, was placed in operation on schedule early in October. The new plant treats slime from the mines' West Reduction gold mill which has been treating 40,000 tons per month of gold ore from the Bird Reef conglomerate beds. The Bird Reef has been correlated with the Vaal Reef at the Stilfontein Gold Mining Company, Ltd's. properties and with the Basal Reef of the Orange Free State gold mines. West Rand is the first of 13 South African gold mines that are building by-product plants to recover uranium.

NORTHERN AUSTRALIA—The Zinc Corporation, Limited, one of Australia's largest mining firms, has been engaged by the Australian government for the rapid development of the Rum Jungle uranium deposits 50 miles south of Darwin. A typical uranium prospectors camp is shown near Rum Jungle.

TASMANIA—Tasmanian Premier Cosgrove reports an aerial survey indicates uranium in southwestern Tasmania, south of Queenstown, in the district pictured on this page. Mount Lyell Mining and Railway Company, Ltd. is beginning large-scale geological prospecting here. The terrain is rugged and only partially explored. Vegetation is often so thick and matted that prospectors walk on top of the wind-blown trees and have to cut their way to the ground to check the geologic formations.

NORTHERN AUSTRALIA



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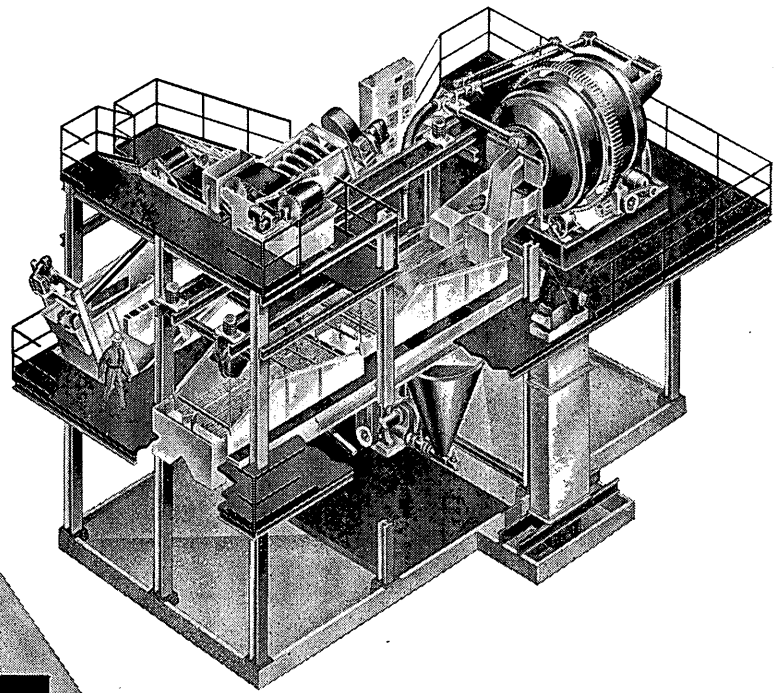

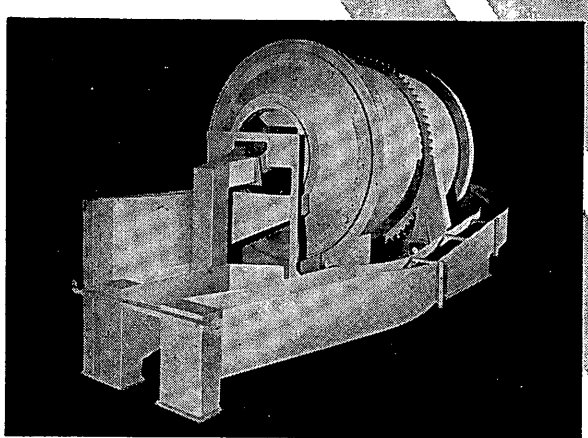

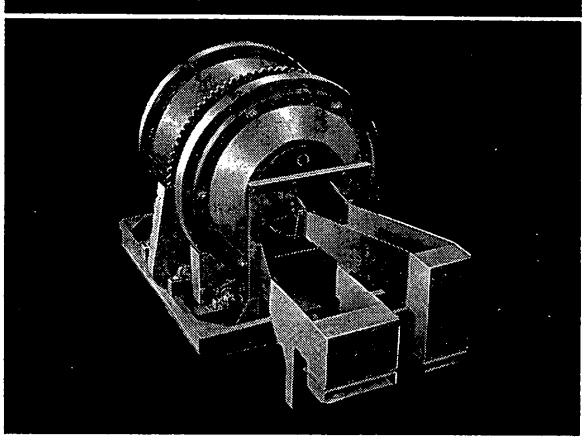

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U. S. - - - A "NEED MORE" NATION

Conventioning miners hear attacks and defense of the Paley Report, and state of strategic minerals industry at Western Division meeting of AMC

"The United States is not a have-not nation but a need-more nation," said Howard I. Young, president of the American Zinc, Lead and Smelting Company and deputy administrator of the Defense Materials Procurement Agency in opening the Metal Mining Show in Denver, Colorado in late September.

He was referring to the recently published 1,000,000-word report of the Presidents Materials Policy Commission, popularly known as the Paley Commission (See *Mining World* August and September, 1952). He urged that the mining industry review its thinking on natural resource problems in view of the changing age in which we live. The report has a forward-looking theme and is the one government report for real discussion and serious thinking within the mining industry, he added.

The Commission and its report were ably represented by Arthur H. Bunker, New York, commission member and president of the Climax Molybdenum Company. It was readily apparent that many did not agree with the stand he took on the report, but all agreed that he did a remarkable job in presenting the Commision's views and sincerely defended its position against all opponents and questioners.

He said, "The overall objective was to insure an adequate dependable flow of raw materials to the United States' industries." He felt that the mining industry had contributed much to the writing of the report and many of its views were incorporated within it.

Industry Advice

The Commission had secured help in compiling the report from industry meetings and advisory groups. A 40-page detailed questionnaire had been sent to 275 domestic metal producers and 60 percent had been completed and returned. The Commission had used the services of various consultants, and a review procedure had been used to obtain opinions of 70 or 80 industry leaders about the report before its final publication.

Andrew W. Fletcher, New York, president of the St. Joseph Lead Company, said that this system of industry advice had no bearing on the final report and that St. Joe had told the Commission for months that it was in error in regard to lead, and still was.

Bunker outlined the growing importance of government in the mining industry and that the report was another example. Government now sets the taxes, monetary and labor policy, establishes prices. It is a regulator of private industry by power and gas allocations; it establishes a foreign policy affecting mining. It is the custodian of resources (mineral lands); it is a supplier of services (U. S. Geological Survey and U. S. Bureau of Mines); it is the largest buyer and user of many mineral products (military, stockpile etc.), and sets the research pattern in many cases.

He concluded by saying that the task of the Commission can never be completed. The report was only the beginning and in the future the industry must carry on the job with the government.

Error In Lead Estimates

Andrew Fletcher opened the industry discussion of the report and confined his remarks to lead—the metal with which St. Joe is most familiar. The Commission foresaw a lead deficit of 900,000 short tons in 1975. St. Joe "guessed" it would be only 200,000. He said he saw "no reason why lead consumers, or any one, should be alarmed about the future lead supply. A comparison of the differences for lead raises great doubts as to the validity of the Commission's findings on other metals."

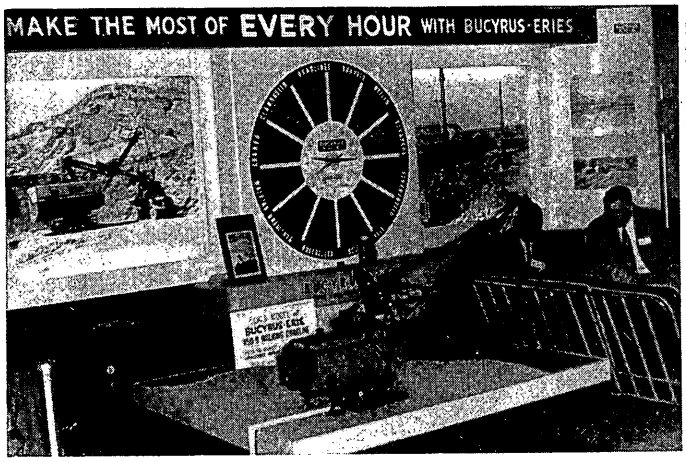
Why Buffer Stocks Won't Work

Simon D. Strauss, vice president, American Smelting and Refining Company, New York, showed why recommendations of the Commission regarding creation of international buffer stocks would not work. Currency difficulties would be insurmountable. What money would they use? Many nations' money resources are already overtaxed. More than 50 nations would agree? Never. A similar international group, the International Tin Committee had accomplished nothing. Tin producers and consumers are fighting. The International Monetary Fund with 54 governments as members had failed at monetary stabilization, so how can an international group stabilize private production of metals? Government control is slow and cumbersome, price judgment had been poor, as shown by English government's recent high price buying of lead and zinc. Such a buffer stock would be subject to political pressures and nationalization. Substitution of politicians for industrialists does not make the cartel recommendations palatable.

Senator Henry C. Dworshak, United States Senator from Idaho, reported on the political aspects of the report. He foresaw arrogant assumptions of congressional power by

GOLD WINNER OFF ONLY 0.083 POUND

C R. Cameron, general superintendent, Lone Star Steel Company, McAlester, Oklahoma (center) holds the $100.00 worth of placer gold he has just won at the *Mining World* booth. His winning estimate of the weight of the gold ore shown on the scale was 188.333 pounds. The actual weight was 188.250 pounds. E. E. Hopper, Evergreen, Colorado was second with an estimate of 188.014 pounds. Five other contestants guessed within one pound of the true weight.



LEFT: The Bucyrus-Erie exhibition featured a scale-size operating model of the giant 1150-B dragline. RIGHT: Operating equipment was displayed outside the convention hall. Pictured here is a Caterpillar tractor equipped with a Traxcavator loader and a Ruth Diesel exhaust gas air conditioner. This complete unit is specially assembled for underground loading.

the executive branch of the federal government in putting into effect certain recommendations of the report.

He warned of the danger of removal of import duties on metals and said such power would jeopardize the mining industry if such power were given to an administrative agency.

Flexible Tariff Needed

Edward H. Snyder, president of the Combined Metals Reduction Company, Salt Lake City, Utah, said that from his experience he would guess "that the over-all ore reserves given in the report are probably less than 10 percent of those that can ultimately be mined." He agreed with the Commission "that the nation can ill afford the waste which is incident to violent fluctuations in metal prices, such as we have witnessed during the past four years," and also agreed that "buffer stocks might be a satisfactory solution to this problem. However, these stocks should be national and not international and operated by regulations spelled out in detail by our congress, and not left to the planners in the State Department or any other government agency.

"On the assumption the world is not going to run out of metal, a flexible tariff to automatically maintain, within reasonable limits, the price level the domestic mining industry must have to perpetuate itself would be far more satisfactory to the taxpayer.

"The Commission's recommendations as to loans, coupled with selective price contracts, provide an unfair type of competition for those who maintain production without government help, and the domestic industry may soon be seriously hurt by surpluses created by such devices."

Defense Minerals Progress

Howard I. Young, deputy administrator of the DMPA, outlined the accomplishments of the agency during its little more than one-year life. Expansion goals have been set, with 1955 the target year. Many different steps have been taken to aid the mining industry in reaching these goals, including purchase and resale contracts, tax amoritization certificates, opening of new mines, keeping high-cost mines in operation, payment of over-ceiling prices, and development of new metallurgical processes. Increased production goals for 1955 over 1951 output are as follows: beryllium, 70 percent; copper, 25 percent; fluorspar, 50 percent; iron ore, 40 percent; manganese, 30 percent; mica, 50; molybdenum, 130; nickel, 35; tungsten, 190, and zinc, 15 percent.

Jess Larson, DMPA administrator, said that he hopes the agency can be disbanded by the end of 1953, and that he is making plans accordingly. It is an emergency organization created by war-time requirements of insuring adequate minerals for military needs and maintaining a high level of civilian production.

Small Mines Session

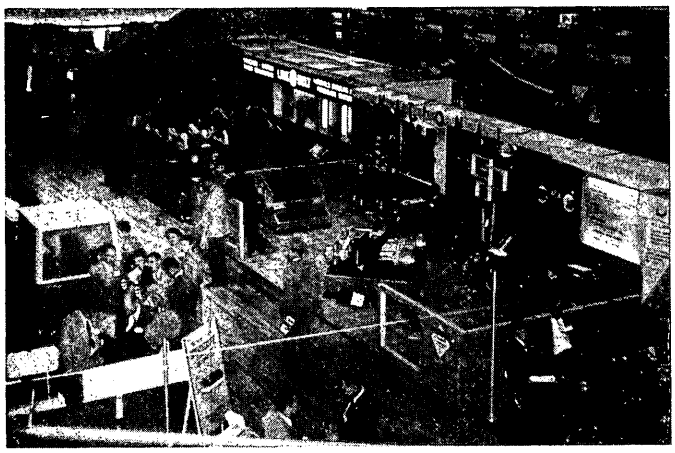
Howard W. Balsley, Moab, Utah, reported on the status of the independent uranium-vanadium miner on the Colorado Plateau. As a result of charges made by the small miners, a marked improvement in sampling practices is now in evidence, he reported. Assaying, however, is another matter, he said. Allocation of U.S. Atomic Energy Commission leases was a difficult job and open to charges of favoritism. He thought that the present uranium bonus for new production was both unfair and unequitable and was actually reducing uranium output, instead of stimulating it as was planned. He said further that the bonus is unfair for those early producers who did much of the pioneering and produced ore when the price was lower and the demand as great. Today there are a number of mines with substantial past production which are idle or operating at a loss. They have produced the maximum amount of ore for the bonus and were therefore shut down because operating costs precluded production of much known low-grade ore without the bonus. He recommended that the bonus be eliminated and that all production be paid for at a consistent uniform price of $7.50 per pound.

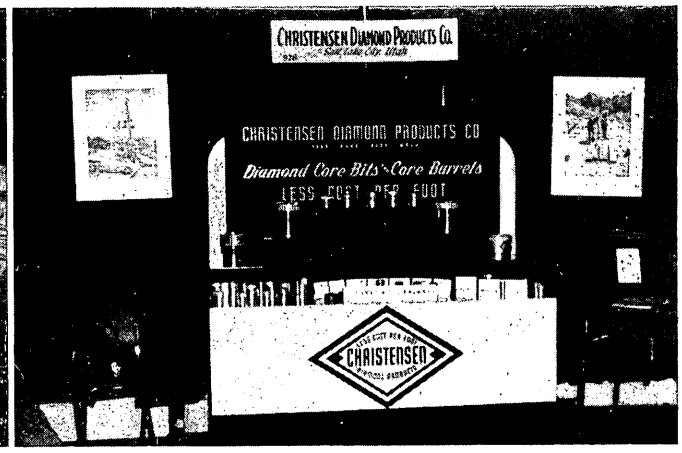
Robert S. Palmer, executive director of the Colorado Mining Association, outlined the need for a strong domestic mining industry in this period when the administration supports foreign mining. He said that "finding new mines in the United States is a good insurance policy regardless of cost," and that "contractual concessions should be extended to small miners and that long term contracts with escalator price clauses should be awarded, because in the small miner is involved the future of America."

Attack From Within

United States Senator Pat McCarran from Nevada warned that a Communist-inspired attack from within could dominate the nation. "The people must realize that the enemy exists and is active within the country under many disguises, using both aliens and citizens. He has already been fantastically successful in achieving some objectives."

"The Communist party may have gone underground, as such, but the Communist conspiracy in the United States is still extremely active. There are in this country today American citizens of good education





LEFT: Visitors thronged into the main display hall to see equipment from all over the United States. Prominent names of equipment manufacturers in the mining world can be seen in this picture. RIGHT: Christensen Diamond Products Company displayed a wide variety of diamond bits and the various types of stones used for setting bits.

and great ability who are doing the bidding of the Communists," the Senator said.

Exploration or Development?

L. J. Randall, president of Hecla Mining Company, Wallace, Idaho, urged that the best method to encourage mine development was to make the cost of exploration fully deductable from income tax returns. He added, "under present laws there is often a great deal of uncertainty as to how we should distinguish between expenditures for development and expenditures for exploration." "For example," he said, "suppose a corporation undertakes an exploration and development program calling for an expenditure of approximately $800,000 over the next two-year period to be financed from profits realized from a presently producing property. The question arises as to whether this expenditure is fully deductible as development cost under existing law or only to the extent of $75,000 per year as exploration cost."

Gold Guarantees Lasting Value

"Hard Money Versus Inflation" was the subject of a talk by South Dakota's United States Senator Francis Case at the Monetary Policy discussion. The time has come, he stated, "when the economist, the engineer, the financier and the miner must join hands in saying to the next administration, whatever it may be and whoever it may include, that the welfare of the country demands recognition by the United States of the full part that gold can play in combating inflation and in restoring economic health to the nation."

"Today there is the need for an effective curb on the fires of inflation. Every producer in whatever field, every buyer of goods in whatever field, every worker in whatever field, will benefit if government and citizen can have the self assurance which goes with the substantial guarantee of lasting values given in terms of gold."

Strategic Minerals

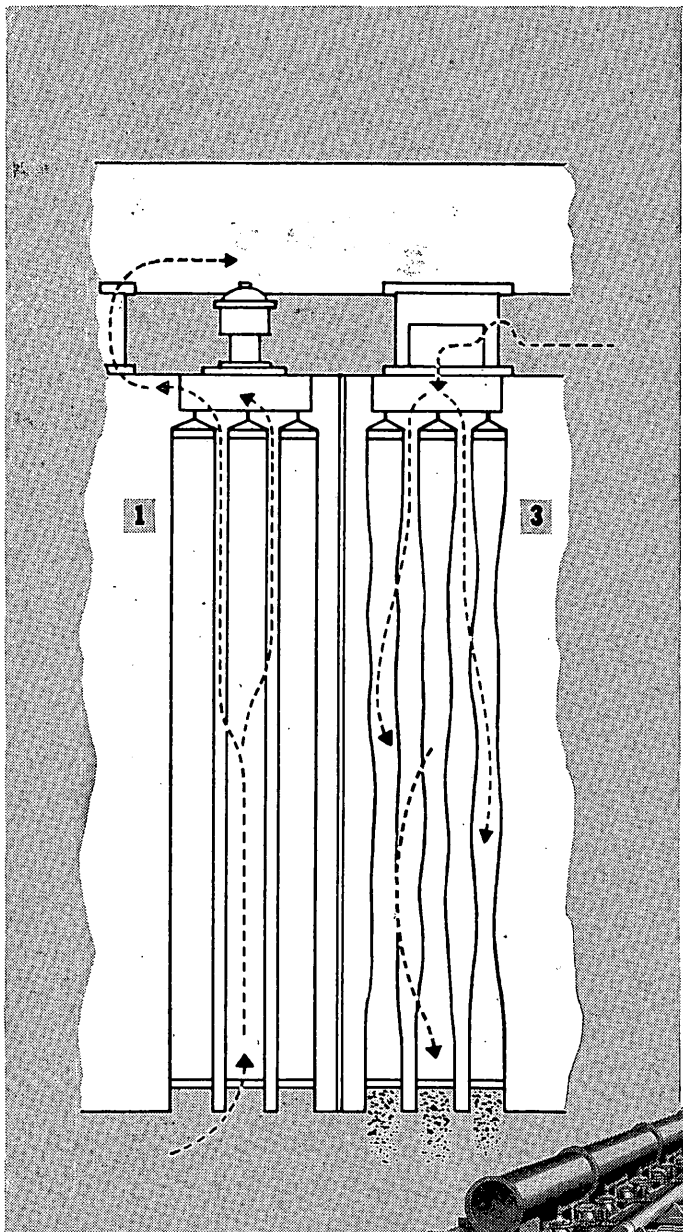
The strategic minerals session brought forth the views, questions and comments of the strategic mineral producers, but unfortunately many of the questions remained unanswered because there were no government planners and policymakers present to outline the administration's domestic strategic minerals policy.

P. R. Bradley, Jr., president of the Pacific Mining Company, San Francisco, said the government's manganese program was a failure and that "today we produce a smaller proportion of our needs than before the program was launched following the start of the Korean war."

James P. Bradley, vice president, Bradley Mining Company, San Francisco, reported that the United States is almost completely dependent on antimony imports and that the "national stockpile is dangerously inadequate, with only a six month's emergency supply." However, the Munitions Board has announced that the stockpile objective for antimony has been completely filled.

W. L. Long, president of the Tungsten Mining Corporation, Warrenton, North Carolina, called on the tungsten producers to establish in Washington, D.C. a Tungsten Institute for education of the government of the necessity of maintaining a good workable tungsten program as a phase of national preparedness.

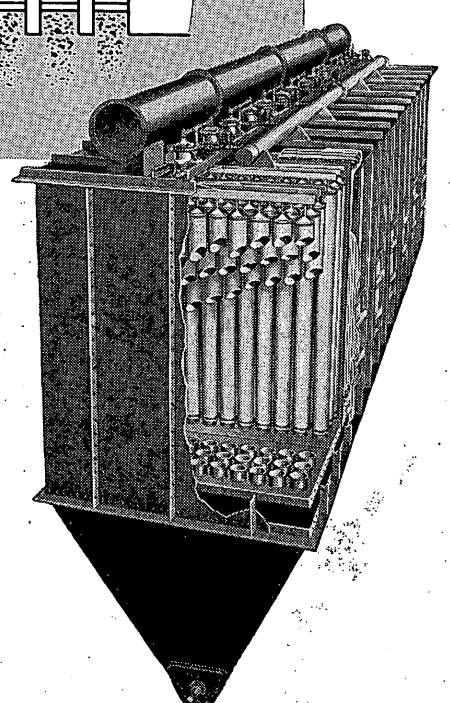
Highlight of the convention was the session on "Strategic Minerals" where the speakers were, from left to right: F. W. Libbey, director, Oregon State Department of Geology and Mineral Resources; Gordon I. Gould, president, New Idria Mining and Chemical Company; James P. Bradley, vice president, Bradley Mining Company; L. Long, president, Tungsten Mining Corporation; Sam H. Williston, vice president, Cordero Mining Company; and P. R. Bradley, Jr., president, Pacific Mining Company.



How Norblo gives you 24-hour-a-day dust collection at full rated capacity

Fast double-action bag cleaning assures full efficiency and constant suction drop across the arrester

No matter what the task in large scale continuous operation, Norblo equipment stands the gaff — with low maintenance and economical over-all cost. Norblo Automatic Bag Type Dust Collectors have been completely reliable in all types of installations for over 25 years, proving the soundness of the operating principles described below:



1 Basic unit compartment houses 78 cylindrical bags — fully distended by upward inside air flow.

2 Variable timing of cleaning cycle, easily adjusted according to dust load, insures constant volume of air handled and constant static pressure drop across the arrester.

3 Bag cleaning involves only one compartment at a time, and only a few seconds out of each hour of operation. During cleaning period bags are shaken and air flow is reversed, loosening dust and accelerating its descent into the hopper. *This double-action bag cleaning insures utmost efficiency of the equipment and in no way interrupts the suction drop.*

4 Any compartment may be cut out of operation for bag replacement or repair, all other compartments remaining in operation.

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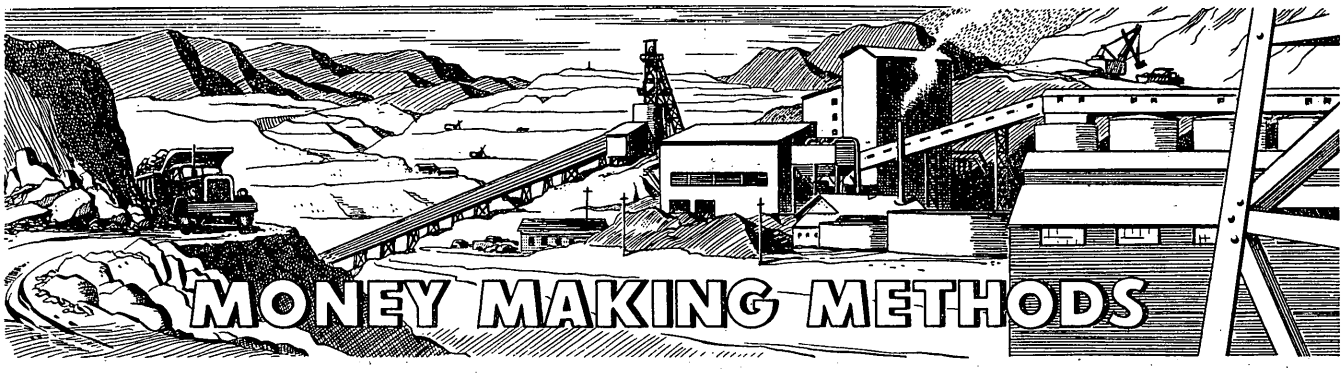


CARE and WEATHER PROTECTION GIVE WIRE ROPE LONGER LIFE

The better care and protection you give wire rope, the better it will serve you. That means you reduce your costs of operation—and who can turn that down these days?

Quality always pays off in a product like wire rope. A high-quality rope naturally possesses high abrasion-resistance, because it is made of finer steel. It also has higher resistance to breaking, either by direct pull or by frequent flexing. That point is demonstrated at the A. Leschen & Sons Rope Co.'s plant, where every coil of wire used in rope manufacture undergoes rigid testing for both tension and torsion. There is a difference in "raw" wire, and when wire is discovered which doesn't meet top-standard requirements it is always rejected. If imperfect wires are stranded into the rope, the rope quality suffers and it wears faster.

Normal abrasion can also be reduced by frequent lubrication—using a thin coat of adhesive lubricant. A study of the operation and the layout may also suggest ways to reduce abrasion. Sometimes it is advisable to increase the load, within safe limits, and to reduce speed as a means of lessening abrasive action. If an operator gets into the habit of starting equipment too fast, he might better slow down, in order to reduce "dragging" in the sheaves or blocks. You'll gain in rope service.

Blocks and sheaves should always rotate freely. Keep bushings well lubricated, so that lines won't be dragged over sluggish equipment. Soft sheaves or sheaves that are too small will show rope treads, which indicate they are unnecessarily hard on rope. These treads mesh almost perfectly with the strands of the rope that make them, but when a new rope is installed it will be entirely out of mesh and the ridges of the treads will become cutting edges with great ability to do damage. This damage will show up first in scratches or cuts. Scratching or scrubbing may also result from poor spooling on drums, which will happen if the rope rolls away from or over the next wrap on the drum. Tight, even spooling, especially on the first layer, reduces wear.

On any line that runs from a drum through a series of sheaves, the portions of the rope that rest on the sheaves and on certain critical points on the drum absorb far greater stresses than the rest of the rope at the moment when the load is fully applied. If the rope returns to its original position for each lift, these parts are bound to wear faster. The solution is to cut off at regular intervals a length of rope sufficient to move these parts from the critical points. Better utilization of the length of the line will result.

A common cause of abnormal abrasion is careless handling. Prying the rope, either to move the reel or to move wraps closer together on a drum, should be avoided. Also avoid sudden severe stresses. Many lines on service jobs are abraded by being dragged across rocks or other objects. Sometimes lines are unnecessarily allowed to touch the ground between the storage reel and the sheave. Especially under warm weather conditions when the lubricant may be tacky, the rope picks up sand which acts as a file on the sheaves. This should be avoided whenever possible, and even if it is necessary to change the layout, savings will justify the change.

A common condition on operations where wire rope must be kept handy for replacement purposes, is to have reels of rope outdoors—exposed to rain, dust, and other elements. When this is necessary a few simple precautions will pay extra dividends. Do not allow the reel to stand directly on the ground or even on a cinder-covered area. Mount it on a reel stand or on heavy timbers, otherwise, the weight of the rope may cause the reel flanges to become embedded and the rope to rest on the surface. This practically guarantees rapid corrosion. A temporary make-shift covering of corrugated iron or any similar material that happens to be handy is helpful. So is good lubrication. But there is only one way to be sure that complete protection is provided. That way is to order your rope with a special protective lepro coating that seals the rope completely from air and moisture. When you get a good, factory-applied coating that forms a hardened, protective surface, your problems on this score are answered.

Two good ways to protect your wire rope are illustrated here. First, mount the reel on timber blocks or a reel stand. Second, order your rope covered with a special protective coating to seal out dirt, air, and moisture.

Muriel Sibell Wolle Describes

BEARTOWN AND STONY PASS

The mountains at timberline at the head of Bear Creek, near the source of the Rio Grande River, were the scene of a gold rush in 1893. The Good Hope and the Sylvanite mines were discovered early that spring and a ton of ore which netted $4,000 was shipped. As soon as prospectors uncovered the rich gold and silver ores, the Bear Creek gold district was organized. As the news of the mines it contained leaked out, a rush was on; men began to hurry toward the gold-bearing deposits, and to stake claims on all sides of the promising lodes.

As each new property was located—the Gold Bug, Silver Bug, Kankakee, Little May, Elkhorn, Bonita, and Chrystal—the trickle of prospectors to the high, exposed valley grew until it became a steady stream. Although the site of the deposits was only 18 miles from Silverton, the location was inaccessible even in the 1890's and could be reached from that town only by crossing Stony Pass. From the east, access was by wagon road from Creede, up the Rio Grande valley to the mouth of Bear Creek. From there, only a rough, steep trail led several miles to the prospect holes.

According to the *Creede Candle* of June 2, 1893, the road for 50 miles "is lined with prospectors, wagons and stages carrying people in and out. The greatest drawback to the camp is the want of a road from the mouth of Bear Creek to the mines. A dozen men with a team could make the road open in a day, and at the miners' meeting held the other night it was decided to do this. Nothing has been done however and probably will not be until one of the miners wants an outlet for ore."

By June 16, the camp was tentatively named Gold Run and "The Candle Company" had "established the *Gold Run Silvertip*—a weekly newspaper with A. W. B. Johnson as editor." By the end of June, it was said that "more prospectors are coming in than are going out and the town is taking shape." A townsite in a park below the falls of the creek and half a mile below the Sylvanite mine was laid out and already had two stores, a saloon, and many prospectors' tents and cabins.

Beartown, Colorado, in the San Juan Mountains.

On the thirtieth, the *Candle* boasted: "If the present rate of growth is kept up Gold Run will be a respectable-sized camp before the snow flies. At present there are 350 to 400 persons here who are prospectors and not real estate boomers. Gold Run has a grocery store, hardware store, newspaper, blacksmith shop, boarding house, surveyor, assayor and other places of business . . . and gives promise of being a permanent camp." Some optimists even spoke of it as a "Creede Annex."

At first the camp was called Gold Run. However, Bear Creek, Silvertip, Hines Fork, and Cub Town were also considered as possible names. A postoffice was opened under the name Sylvanite, but by the time the postmaster received his commission, he was unable to get to his office on account of the amount of snow which obstructed the trail.

Just when the camp became known as Beartown, I do not know, but in 1948 when I visited it little except its mines were left. I approached it from the eastern side of the San Juan and Needle mountain ranges and drove from Creede up the Rio Grande valley to Lost Trail camp. From there I rode horseback up the old wagon road, over Timber Hill to the mouth of Bear Creek.

As soon as we crossed the summit of Timber Hill and started down the far side, we could look up another valley and follow the tiny sliver of trail to its end, where Beartown lay. A mile up the valley was an old stage station—a big cabin with its roof caved in. Far in the distance was another building, a lone cabin in a big meadow. At the edge of the meadow was the wreckage of a mill. The debris and the cabin were Beartown today!

Beyond the town site, the trail leads to a ford at the base of Bear Creek Falls and continues up to the Sylvanite mine and its group of buildings. The assay office was full of equipment and the hotel or boarding house was furnished with

(*Continued on page* 98)

ACTIVITIES OF U. S. MINING MEN

Franklin Gray Pardee has been elected president of the Lake Superior Iron Ore Association. Mr. Pardee, previously state geologist of Michigan, succeeds the late **M. D. Harbaugh.**

Frank E. Johnson is new deputy administrator of the Defense Minerals Exploration Administration. He has recently been serving as acting deputy administrator and also has been special assistant to the DMEA administrator. Mr. Johnson has been connected with government metal and mineral agencies for 17 years and, previous to that, worked in the industry for 13 years.

Meryl H. Geisking has been appointed to the newly created position of assistant to the president of the Tennessee Coal and Iron Division, United States Steel Company.

New instructors in the mining engineering department of the Colorado School of Mines are **Niles Grosvenor** and **Thomas G. Morrow.** Mr. Grosvenor received his M. A. from Colorado in 1952, and Mr. Morrow was employed by the New York and Honduras Rosario Mining Company, Honduras.

Alan T. Broderick of Iron River, Michigan, has resigned as regional geologist for the M. A. Hanna Company to become chief geologist with the Inland Steel Company, Ishpeming, Michigan. He previously had done geological work in Mexico and Peru, and with the Bunker Hill and Sullivan Mining Company in Idaho.

Four new directors of Washington's Delemar Mining and Recovery Company were elected recently. They are **H. N. Loding, Roy Farley, Conrad Hergert** and **W. R. Splater.**

Walter S. Palmer, chairman of the department of metallurgy of the Mackay School of Mines, University of Nevada, has retired. He had been connected with the University of Nevada for 42 years.

A. J. Windl of Oglebay, Norton & Company has been elected treasurer of the Lake Superior Mines Safety Council. He succeeds **E. W. R. Butcher,** chief mining engineer for the Republic Steel Corporation, who was treasurer of the council for 27 years.

LAWRENCE LITCHFIELD, JR., has been elected president of Alcoa Mining Company of New York City, and of Surinaamsche Bauxite Maatschappij in Paramaribo, Suriname, both subsidiaries of Aluminum Company of America. He succeeds Frank B. Cuff who has retired. Mr. Litchfield has been serving as vice president of both of these firms. He is a veteran of 27 years of service with the company, having joined ALCOA in 1925 as geologist and mining engineer. He is also president and director of Alcoa Exploration Company.

Harold Worcester has resigned as vice president and general manager of King Leasing, Inc. at Ouray, Colorado. He is now a consulting engineer, with headquarters in Montrose, Colorado.

Theophilus M. Rizzi, June graduate of the South Dakota School of Mines, is a new geologist for Homestake mining Company in Lead, South Dakota.

Richard A. McDonald, employed by the Crown-Zellerbach Corporation in San Francisco, was recently appointed director of the National Production Authority. He succeeds **Henry Fowler,** who now is head of the Office of Defense Mobilization and of the Defense Production Administration.

Clarence H. Sleeman has been appointed general mining engineer of the Jones and Laughlin Steel Corporation, Minnesota Ore Division. The former assistant chief engineer will make his headquarters at Virginia, Minnesota on the Mesabi iron range.

Hollis G. Peacock has resumed his position of geologist for the United States Smelting, Refining and Mining Company in the Utah area. Mr. Peacock's headquarters will be in Salt Lake City for a year, after which he will transfer to Boston, Massachusetts.

Rip V. Thompson, former mill superintendent for Utah's Metal Producers, is now metallurgist for Manganese, Inc., at Henderson, Nevada.

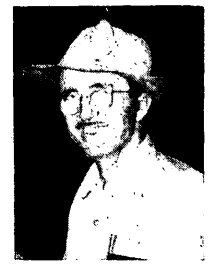
At the Oliver Iron Mining Division, United States Steel Company, **John B. Parden** has been promoted from maintenance engineer to locomotive repair foreman of the Virginia district mines. **W. J. Belobraidich,** mining engineer with Oliver Iron, has been transferred to Ironwood, Michigan from the Hibbing-Chisholm district. New Oliver appointments include **Donald Van Prooien** and **David B. Olin,** civil engineers, **Eildon C. Ferreiro,** geological engineer, and **Rodney Bleifuss,** geologist.

New directors for the Pilot Silver-Lead Mines, Inc. of Wallace, Idaho are **O. L. Jones, James Doyle, Jr.** (president of the board), **Piatt Hull, C. W. Bentley** and **William E. Cullen. William A. Calloway** was appointed secretary-treasurer. **James A. Allen** and **L. G. Smith** have resigned as president and secretary, respectively.

James R. Carr, mining engineer, and **Harold R. Hayes,** mechanical engineer, are new additions to the staff of U. S. Gypsum Company in South Dakota.

J. R. Rand, geologist for the Copper Range Company, has moved to Ontonagon, Michigan, where he will devote most of his time to the White Pine copper mine development.

Robert Sayre has resigned as engineer for Minerals Engineering Company, Grand Junction, Colorado, and is now employed as mining engineer at the Climax Uranium Company in Grand Junction.



H. M. (LINDY) LINDHOLM has been sent to the Union of South Africa by the U.S. Atomic Energy Commission to advise on the extraction of uranium from gold mine tailings. Before joining the staff of the AEC, he had been a metallurgist for the Anaconda Copper Mining Company at its lead-zinc flotation mill at Darwin, California.

E. W. Geist, formerly in charge of M. A. Hanna Company's Groveland pilot plant at Randville, Michigan, has returned to the company's research laboratory in Hibbing, Minnesota after completing the test run at Randville.

J. R. Gross has been appointed mining engineer at the Wentworth mine of Jones and Laughlin Steel Corporation, Minnesota division. **R. H. Ledin** has been transferred from Jones and Laughlin's Hill-Annex mine to the new Lind-Greenway mine east of Grand Rapids, Michigan. He has been succeeded by **Jean Lentz.**

Dale S. Strand is a new addition to the mining engineering staff of Cleveland Cliffs Iron Company in South Dakota.

R. G. Sullivan, vice president and general manager of Minerals Engineering Company at Grand Junction, Colorado will leave the United States on December 1 for a trip to Australia, Tasmania, and New Zealand. While in Australia he will advise the Australian government, the Australian Department of mines, and joint United States-Australian atomic energy groups on uranium prospecting techniques. Special emphasis will be placed on diamond and non-core drill holes for sampling. Mr. Sullivan has had wide experience on the Colorado plateau and is a pioneer in the development of long-hole drilling and sampling there.

S. E. Erickson has been elected chairman of the minerals beneficiation division of the Minnesota section, American Institute of Mining Engineers.

J. Frank Sharp is new chief geologist for Consolidated Coppermines Corporation of Nevada. Mr. Sharp has been with the firm for 15 years, and during the past year served as exploration superintendent.

New employees of the Oliver Iron Mining Company in Lead, South Dakota are **Robert Kooiman,** general engineer; **Douglas Brackwell,** metallurgical engineer; **Robert O. Biddle, Martin T. Giavelli, Thomas Mohr, Grove A. Rathburn** and **Harold F. Unger,** mining engineers.

Kenneth R. Hama has been appointed works metallurgist at the

Duluth plant of the American Steel and Wire Division of the U. S. Steel Corporation. He succeeds **Robert C. Weed**, who has retired.

Edward C. Colson, sales engineer for Arizona Equipment Sales, Inc., Phoenix, Arizona, was recently elected to membership in the American Institute of Mining and Metallurgical Engineers.

New employees of the E. J. Longyear Company in Minneapolis, Minnesota are **Arthur Nelson** and **George Murray**.

Marshall Haney, mining engineer from Takoma Park, Maryland recently completed the examination of several manganese deposits located in Virginia and Tennessee.

Paul Hoeft has been appointed master mechanic at the Anvil-Palms iron mine, Ramsay, Michigan. He succeeds **Albert Beissel**, who has retired.

Luther R. Branting, works manager of Alcoa Mining Company's Bauxite, Arkansas operations, has retired after actively serving with the company for more than 32 years. He has been succeeded by **J. Thad Watters**, who has been assistant works manager since March.

Merlyn G. Woodle, assistant superintendent for the Republic Steel Corporation, Mesabi range, at Hibbing, Minnesota, recently returned from a trip to the Bomi Hills iron mine in Liberia. Republic has extensive interests in that country.

D. G. Malherbe, mining engineer for the Union of South Africa government, recently visited the United States to confer with technical officers of the U. S. Atomic Energy Commission regarding the uranium program of the Union. Within a few years South Africa will be the largest producer of uranium in the world.

New officers of Colorado's Clear Creek Metal Mining Association are **Major Ellis P. Lupton**, president; **Douglas Watrous**, vice president; **Charles Trask**, secretary, and **Harry Walder**, treasurer.

Morris V. Mielke, former assistant concentrating engineer at the Oliver Iron Works research laboratory, has been appointed superintendent in charge of the company's Extaca plant (experimental taconite agglomeration plant) at Virginia, Minnesota.

Ernest F. Bean, Wisconsin state geologist since 1925, has retired. He had been with the Wisconsin State Geological Survey since 1917.

Professor George P. Schubert, member of the mechanical engineering department at the Michigan College of Mining and Technology, has retired after being a faculty member for 30 years.

First officers of the recently-organized Iron County Engineers' Club in Michigan are **Philip D. Pearson**, president; **Jack Morrow**, vice president; **Richard Brewer**, secretary, and **John Torreano**, treasurer.

Warren E. Fisher, who has been head of the geological department of Inland Steel Company since 1946, has resigned to undertake the job of exploring Kennecott Copper Company's new central district. As field engineer, Mr. Fisher, and **C. H. Burgess**, district geologist, will explore an area reaching from Canada to Mexico and from the Rocky Mountains to the Appalachians.

JAMES A. RABBITT, Inco consulting engineer, and an authority on Japan and the Far East, has retired from active service with The International Nickel Company, Inc. after more than 22 years of service. He will be available in an advisory capacity on Far Eastern affairs. During World War II, Mr. Rabbitt served in the U.S. as technical consultant on Japanese industries and was also a member of the Panel of Far-Eastern Experts in Washington.

Anton Tancig has resigned as mechanical superintendent for Minnesota's Snyder Mining Company after 44 years of service. He is credited with having been first to suggest electric power shovels for Mesabi open-pit mines, classifiers in its washing plants, and electric motor-driven tugger hoists for its underground mines.

W. R. Herrmann is now metallurgist at the American Steel and Wire division plant of the United States Steel Corporation in Duluth, Minnesota.

Henry Ford, mining engineer with the Verona Mining Company, is now assistant mining captain at the Buck mine of Pickands, Mather and Company.

O. H. Strand is a new vice president for William H. Ziegler Company of Minnesota, succeeding **Larry T. Gavin**, who has retired.

N. J. Knickerbocker is one of three partners who are operating a lead-zinc mine at Rico, Colorado.

Former resident Engineer **Howard T. Caddy** has resigned from the Minnesota Ore Division of Jones and Laughlin Steel Corporation. **William Betzler**, chief mining engineer at the Longyear mine in Hibbing, Minnesota, has been transferred to the Schley-Pettit mines at Gilbert. All are properties of the Jones and Laughlin Minnesota Ore Division.

Dr. Victor T. Allen, director of the geology department at St. Louis University, has received a grant from the Geological Society of America to study pyroxene, a hard, tough rock with no commercial use which often is found in zinc, iron, and other ores. Dr. Allen gathered specimens last summer in New Mexico and Mexico, and will spend the winter analyzing them.

Gordon R. Wynne has been appointed assistant superintendent of the Extaca plant of the Oliver Iron Mining Division at Virginia, Minnesota. **Morris Mielke** is superintendent.

Ernest R. Gustafson, former chief of hydraulics and international water control at the Duluth, Minnesota office of the Corps of Engineers, is now stationed at the St. Paul, Minnesota office.

Dr. Cyril Stanley Smith, former member of the Manhattan Project, will be awarded a Francis J. Clamar medal by The Franklin Institute of the State of Pennsylvania for his metallurgical contributions to the development of atomic energy during and since World War II. Dr. Smith, professor of metallurgy and director of the Institute for the Study of Metals at the University of Chicago, did research on the metallurgical behavior of elemental plutonium.

New officers and directors were elected for the Great Eastern Mining Company of Silverton, Colorado. They are: **Art Linkletter**, chairman of the board; **Allen Chase**, president; **Edward P. Chase**, executive vice president and general counsel; **Dr. T. B. Morgan**, vice president; **George Newton**, director; **William A. Way**, local counsel; **William L. Chase**, secretary and treasurer; **E. T. Chase**, comptroller; and **Carl Larson**, assistant secretary and chief accountant.

Ernest R. Gordon has been appointed chief of the Grand Junction exploration branch of the Atomic Energy Commission, transferring from AEC's New York staff. He follows **Thomas W. Oster**, who has gone to Australia to assist in uranium development.

Louis P. Gaggini is new chief of the Colorado uranium division of J. R. Simplot Company. Mr. Gaggini, who will make Grand Junction his headquarters, has been employed by the Dulaney Mining Company for the past nine years.

Guinn E. Metzger, a 1948 graduate of the Colorado School of Mines, has been awarded a Fulbright scholarship to study at the Royal School of Mines, University of London. Mr. Metzger recently was assistant professor of mining and metallurgy at the University of Alaska.

Dr. Ernest W. Greene has been elected executive vice president and director of research of Minerals Separation North American Corporation, a firm headed by **David E. Lilienthal. Earl H. Brown**, co-inventor of Minerals Separation's processes for treatment of low-grade iron ore, is his new assistant.

J. W. Ribotto has been named metallurgical engineer at the Magna concentrator of the Utah Copper Division, Kennecott Copper Corporation, succeeding **C. G. Williams**, who has retired. **John L. Moore** is now general mill foreman at the Arthur mill, and **Elmer C. Speers** is grinding and flotation foreman.

J. E. Papin, an employee of Phelps Dodge since 1927, is the newly appointed concentrator superintendent of the Morenci Branch of Phelps Dodge Corporation in Morenci, Arizona. He succeeds **H. T. Herivel** who has been named consulting metallurgist for Morenci.

Harold Kirkemo, mining geologist, has resigned from the staff of Anaconda Copper Mining Company's Spokane, Washington exploration office to accept a position with the U. S. Geological Survey. He will be assigned to the USGS Spokane regional office, and will work on the defense minerals exploration program.

Robert S. Palmer, executive secretary of the Colorado Mining Association and one of the founders of the United States Gold Committee attended the International Monetary Conference meetings held in Mexico City, Mexico early in September. The well-known expert on gold and silver represented the groups at the meetings.

ADVANCES IN MINE MECHANIZATION

Miners at the Metal Show heard in the technical sessions how mechanical equipment operated, and then actually saw it operate at exhibition booths

Mine mechanization and mine equipment development are not static in the United States.

Faced by today's rising costs and the lessening grade of deeper ore bodies, mining engineers and equipment designers have cooperated with machinery companies in developing and building mechanized mining equipment for the newest mining techniques.

This was the report of operators and engineers at the metal mining show and exposition of the Western Division of the American Mining Congress held in Denver, Colorado, late in September. Over 150 equipment manufacturers and suppliers displayed their latest equipment to backup the operators' reports.

Many technical reports were presented to describe progress in mechanization, open-pit mining, shaft sinking, roof support, milling procedures, prospecting and exploration, new metallurgical processes, and rock drilling.

Of greatest value to those in attendance was the fact that after hearing how a specific piece of equipment was used they could walk to the display section and see, examine, and operate the equipment themselves.

Abstracts of several of the papers which were of widespread interest follow.

Drilling Progress At Homestake

By C. N. Kravig, Mine Supt.
Homestake Mining Company
Lead, South Dakota

The Homestake Mining Company has engaged in a fairly comprehensive testing program on drills, drill bits, rods, and drilling for the past five years.

After five years of testing, tungsten carbide bits have been adopted in all drifting and raising and are being adopted in stopes as rapidly as the drifters can be replaced by lightweight hand-held drills and air legs. Tungsten carbide bits have replaced the one-use bit in all applications. The change was not based on the cost per foot drilled (which has been higher) but because of greater production per man shift and therefore better cost per ton. Costs per foot drilled with 1⅜-inch tungsten carbide bits and ⅞-inch hexagonal drill rods are improving with experience. Recently we started an 8 by 8-foot drift with lightweight hand-held drills and air legs combined with 1⅜-inch tungsten carbide bits. This is the same equipment used in stopes. Results to date are satisfactory, and this lightweight equipment may well replace drifters in the near future. This equipment permits a complete cycle of mucking, drilling, pipework, trackwork, and blasting in one shift. Rate of advance is eight feet per eight-hour shift. Use of tungsten carbide bits in raise work with a greater drilling speed has permitted a longer round with a one-shot blast and a complete cycle in one shift. Experimenting with lightweight stopers and 1⅜-inch tungsten carbide bits is scheduled for the near future.

Homestake has recently changed from one-use steel bits in combination with 3½-inch drifters and one-inch Q.O. drill rods to lightweight hand-held drills and pneumatic legs combined with ⅞-inch collared hexagonal drill rods and 1⅜-inch tungsten carbide bits. This new lightweight equipment has increased production materially. Total footage drilled in a shift has increased over 50 percent, and contract earnings have increased substantially with less physical effort. Air consumption is cut nearly 50 percent.

Results to date show substantial increases in production. Miners prefer new equipment since it materially increased their contract earnings with less physical effort on their part.

Truck Haulage As Used At Southwest Copper Mines

By H. C. Weed, Asst. Gen. Mgr.
Inspiration Cons. Copper Co.
Inspiration, Arizona

Ten copper mines, Castle Dome, Cananea, Bagdad, Inspiration, Ray, Bisbee East, Copper Cities, Morenci, Ajo, and Chino, in the southwestern United States and northern Mexico are using trucks in some phase of open-pit mining. At present 173 trucks move an average of 262,500 tons of material each day, or an average of 1,517 tons per truck per 24-hour work day. Assuming 307 work days per year, over 80,500,000 tons will be moved by trucks at these 10 mines in 1952.

The pay load of the trucks in use varies from a low of 15 tons for a few of the older trucks to 45 tons for two Tournarockers which are used as trucks in one mine. The majority carry a pay load of from

"Times Have Changed" was the theme of the Atlas Powder Company. Today's modern blasting agents were unimagined only a few years ago.

22 to 35 tons with all of the newer trucks carrying 30 or more tons.

Buda, Cummins, General Motors, and Hercules Diesel engines are used in the trucks with Cummins being in the majority. Allison gasoline engines are used in the Tournarockers. All trucks are rear dump and all have power steering. Torque converters are used in 76, or approximately one-third, of the trucks. The makers of converters are almost evenly divided among Allison, Schnieder, and Twin Disc. Only one operation is without at least one truck equipped with a Torque converter, and this operation reports Torque converters on order for all of their trucks.

All operations load trucks on both sides of the shovel. Six of the 10 companies use a pit man or a spotter at the shovel. The duties of this man include cleaning rocks from under the tires before starting the truck and cleaning rocks from the truck pattern before backing in a truck, as well as responsibility for the proper spotting of the truck. At the waste dump a berm is maintained at six operations and seven keep a pit man or spotter at the dump. In some cases the man also acts as a sampler. In four of the pits, right-hand driving is standard, while two report left-hand drive as standard. The four others drive either right or left as local conditions indicate advantages. No difficulty from a safety angle was reported by these last four mines. The average length of haul ranges from a low of 0.3 miles to a high of 2.5 miles, and the grades on the haul from a low of 3.0 to a high of 18.0 percent.

Tires are an important item of cost in truck service. Tire life as reported in miles ranges from a low of 10,000 to a high of 22,500. This varies greatly with the single rear-axle truck and the dual-axle truck which carries four more tires per truck. It is interesting to note the highest averages are reported by companies who use dual rear axles exclusively and the lowest from those using single rear axles exclusively. On the basis of an estimate, it would appear that the total tire cost per mile does not vary greatly between the two types of trucks. Recapping of tires is standard practice of eight companies. In recent years the cost of a recap has not risen as rapidly as the cost of new tires which favors recapping. It is, however, essential that a tire be recapped before the carcass is damaged and a tire which requires too many section repairs will not ordinarily pay out the cost of the repairs and the recap.

Rock Bolting at Sunshine

By W. B. Foster, Engineer
Sunshine Mining Company
Kellogg, Idaho

To date, some 5,000 bolts have been used at the Sunshine mine, and, with one exception, every use has given the support expected. The one exception involved a stope that had been mined to the height required for the first gob. Some 50 bolts were driven in the hanging wall of the first two floors, but since this stope had been in operation several months before the bolts were installed, the hanging wall had become loosened to such a depth that bolts were not effective.

On February 18, 1952 the first rock bolts used at Sunshine were driven on the 3,250 No. 4 winze station. This station had been enlarged and would have required station sets to support 600 square feet of open ground.

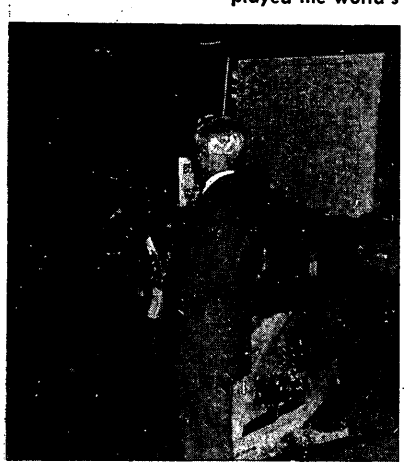
120 bolts, one inch in diameter by six feet in length, were used with ⅜ by 8 by 8 inch bearing plates, and the nuts set to the maximum with an I. R. 534 Impact Wrench. An R 38 stoper was used for the drilling and both drilling and bolting were done by a timber repairman and his helper. This has become the standard crew for the work.

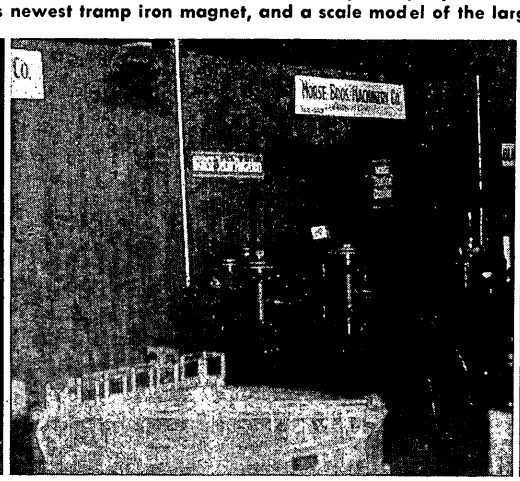
On this particular job, the bolting pattern was required to support 25 square feet of ground for every five bolts. To date, the ground is secure and no ground has sloughed from the bolted area. This same pattern of bolting has been used on all station bolting and has given the service expected.

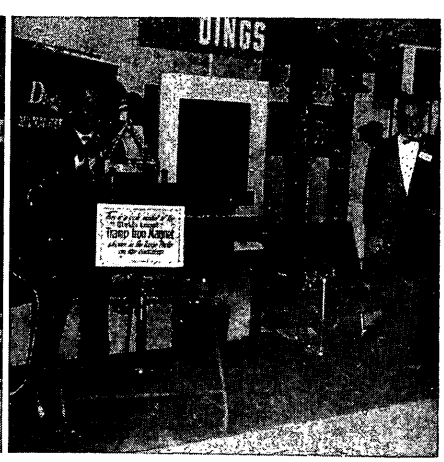
Rock bolting in drifts and crosscuts was started soon after the station work was well underway. The hanging wall and footwall of drifts consist of silicified St. Regis quartzite, laid in beds four inches to two feet in thickness. Drifts, in general, strike east and west, with the veins and accompanying shearing dipping 70° to the south. The shear zones in which the veins occur are along the steeply dipping north limb of the Big Creek anticline. The bedding therefore in general dips 80° and steeper to the north with occasional slight overturning. The combination of the north dipping beds and the south dipping schistosity intersecting at a maximum angle of 30° produces a weak, slabby hanging wall. The bedding has a tendency to become loosened through exposure and shock, and large slabs slip or fall into the drift.

To overcome this condition, six-foot bolts were installed in a fan-like pattern. The bolts are placed at centers of approximately 2½ feet on the cross section of the drift and each fan-like pattern is placed at centers of four feet along the length

LEFT: The Buda Company displayed its heavy-duty Diesel engines. CENTER: An operating plastic scale model of the new Concen-Tank thickener is shown in the foreground at the booth of the Morse Brothers Machinery Company. RIGHT: The Dings Magnetic Separator Company displayed the world's newest tramp iron magnet, and a scale model of the largest tramp iron magnet.

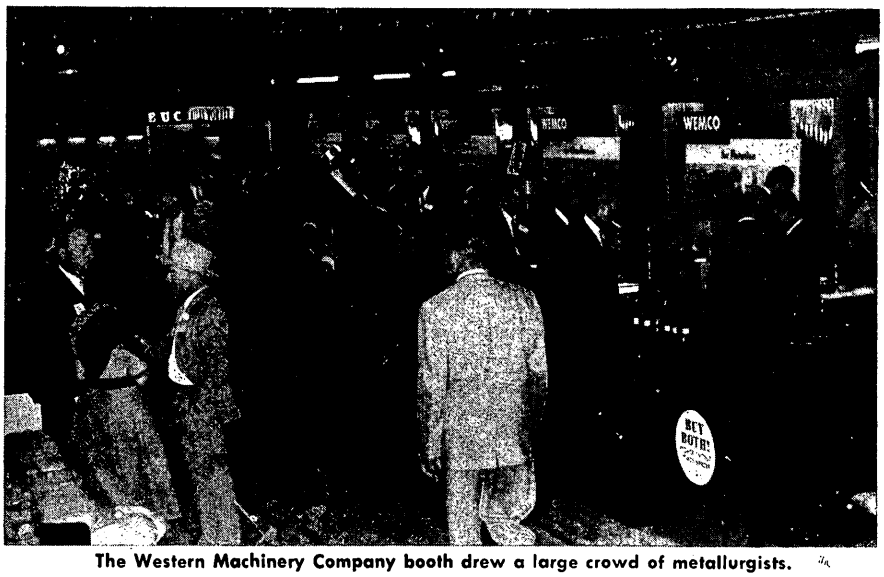






of the drift. Each fan consists of six bolts, beginning at hip height on the wall and extending up the wall, across the back, and down the other wall. In some cases it is necessary to add one or more bolts to give the required support. This pattern has given remarkable service under the most severe conditions.

On July 16, 1952, a severe rock burst occurred in the vicinity of the 3,700 and 3,840 levels of the Sunshine Mine. On the 3,840 level, a section of the cross-cut, 100 feet in length, had been bolted. The same fan pattern of bolting had been used, with an occasional bolt between each bolted section. The rock burst knocked down a large amount of rock along the cross-cut, but within the bolted section, no rock was loosened nor had fallen. This section of cross-cut was thoroughly examined for broken or loose bolts. None were found.



The Western Machinery Company booth drew a large crowd of metallurgists.

Inclined Shaft Mucking

By F. W. Sauerwein, Engineer

New Jersey Zinc Company
Ogdensburg, New Jersey

The northward extension, in depth, of the Sterling ore body required the sinking of an auxiliary underground shaft. The sinking of the lower portion of this inclined shaft led to the development of a mechanical mucking method that proved itself beyond expectations.

The North ore body shaft is a three compartment, 52° slope of 8 x 18-foot cross section, extending 1,045 feet below the 1,850 level. The 52° pitch of the shaft ruled out any application of scraper and slide loading directly to a skip, while the limited shaft dimensions, both as to length and headroom, made difficult the use of scraper and loading pan or bucket. Consideration was given to an inclined shaft mucker embodying the principle of an undercutting shovel bucket, as well as a recently developed machine with a bucket operating in a manner similar to a clamshell. In the operation of these muckers, it was felt that the necessity for hoisting each bucketful to the dumping point through a distance of over 1,000 feet, or intermediate muck transfer, was a definite disadvantage.

The final mucking method evolved consisted, in principle, of a dragline bucket. A toothed-lip bucket was designed and constructed in the shops at minor expense and operated experimentally on the muck pile produced by initial sinking at the 2,450 level. The 13-cubic-foot bucket is 18 inches high by 30 inches wide with top and bottom lengths of 42 and 48 inches, respectively. Pull and tail ropes are hooked to either end and the bucket is hoisted through a stationary sheave located at the front.

From the first trial runs it was evident that the bucket could be filled efficiently, one or two passes being sufficient in most cases, and, with the exception of a counterweight added to the rear to prevent overturning, no major alterations to the original design were required. A 20-foot-long sinking cage was constructed consisting of a wheeled chassis containing three built-in steel platforms. On these were mounted three air-driven hoists, a single drum at the upper and lower platforms and a double drum at the center.

When operating, the cage is positioned on the 42-inch-gauge shaft track in the center compartment and 10 to 30 feet above the muck pile, depending on the cycle. The regular 50-cubic-foot ore skip operates on the second track and is so placed that its top is level with the lower end of the cage. All cables from the hoists pass through rope blocks hung from pins secured in the shaft hanging wall directly above the lower end of the cage.

The ropes from the double drum hoist, after passing through the hanging wall blocks, continue down to blocks located at either end of the shaft a few feet above the muck pile, the pull rope to one, the tail rope to the other, thence to the front and rear of the bucket. As the muck pile recedes, the blocks at the shaft ends are lowered not more than twice during the mucking cycle. The cable from the upper hoist, after passing through the hanging wall block and the sheave at the front end of the bucket, is dead-ended to a pin in the hanging wall adjacent to the rope blocks.

In loading, the bucket is pulled through the muck pile until filled, then pull and tail ropes are disconnected by means of open hook attachments, and the upper single-drum hoist raises the bucket to the dumping position.

The cable from the lower hoist, passing through one of the overhead blocks, is then hooked to the rear of the bucket, while a fixed chain, suspended over the skip, is attached to the bail. With proper manipulation by the operators of the upper and lower hoists, the lip of the bucket is lowered to rest on the edge of the skip, the bottom is raised, and the muck discharged into the skip without spillage.

During the mucking cycle, cage stability is insured by means of a small demountable screw jack braced against the hanging wall, while the upper end of the cage is pinned to the footwall. It was found that three or four shaft rounds could be mucked from the same equipment set-up before bucket hoisting distance became excessive.

In the mucking cycle, four buckets were required to fill each skip and the record attained in one shift of seven actual working hours was 46 skips—approximately 220 cubic feet of muck, or one skip every nine minutes. This entailed hoisting 184 buckets at slightly over two minutes per bucket. Experience indicated that insofar as the mucking cycle was concerned, five or even four men would have been sufficient since on several occasions the absence of one man from the crew caused no appreciable loss of efficiency.

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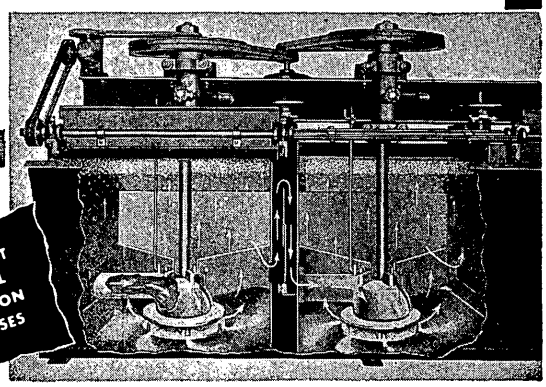

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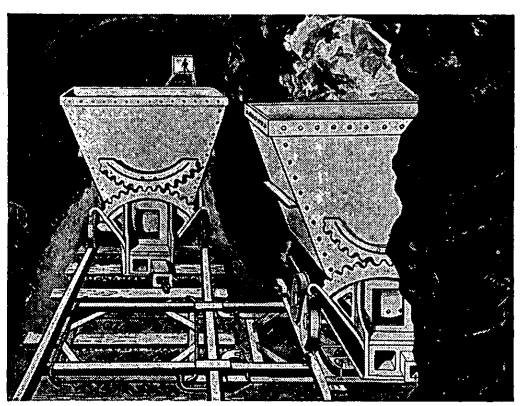

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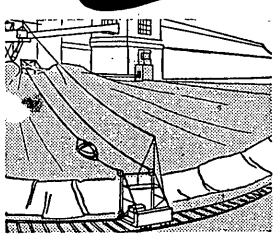
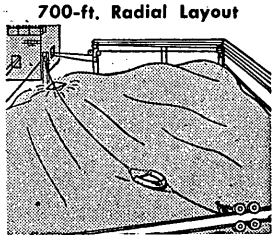
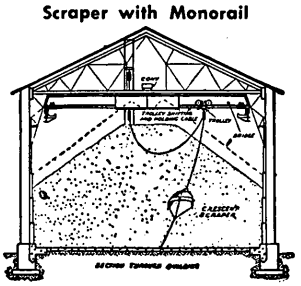


700-ft. Radial Layout



Scraper with Monorail



Scraper in Storage Shed

ACTIVITIES OF INTERNATIONAL MINING MEN

STUART H. STUBBS is owner-manager of the Comet gold mine at Marble Bar in Western Australia. Marble Bar is one of Australia's most isolated mining areas, and is also distinguished as one of the hottest. The record is more than 160 consecutives days with temperatures of over 100°. Mr. Stubbs recently visited Victoria and New South Wales. He currently plans to open up some copper deposits such as the Whim Creek mine.

Claude W. Courand has been appointed director of the Defense Materials Procurement Agency's new office in Lima, Peru. Holding the rank of Minister of the United States, Mr. Courand will direct DMPA's activities throughout South America, except in the Guianas. DMPA has one other office outside the continental United States, the Region III office in London, England, which is headed by **Brigadier General Thomas B. Wilson.**

Three British mining men from the Phosphate Development Corporation, Ltd., of Pretoria, Union of South Africa, recently toured the Florida Phosphate Division of International Minerals and Chemicals Corporation. The group, which included **Gustav S. Preller**, manager, **B. M. Van Bergen**, mining engineer, and **D. J. du Plessis**, chief chemist, received a first-hand briefing in the processing and mining of phosphate rock. The British firm has been prospecting for phosphate for seven years, and expects to begin mining and processing within two years.

J. F. (Jack) Findlay, Mexican representative of Howe Sound Company for the past 14 years, has retired and is now at Madeira Beach, Florida. He has been succeeded by **Bryan W. Brown** of San Luis Potosi, Mexico.

John R. Paris is new general manager and chief engineer of Eastern Mining and Metals Company, Ltd., Bukit Besi, Dungun, Trengganu, Federated Malay States. He formerly was associated with the Malayan Collieries, Batu Arang.

W. P. Ryan, former mine superintendent of the Siglo XX mine property of Patino Mines and Enterprises Consolidated, Inc., is now employed by the Cerro de Pasco Corporation in Peru. **K. O'Donnel** succeeds Mr. Ryan.

R. Cornwaite is new underground manager at Chibuluma Mines, Ltd. at Mufulira, Northern Rhodesia. He previously was a foreman at Roan Antelope Copper Mines, Luanshya, Northern Rhodesia.

Charles Will Wright, American specialist on foreign mines, recently flew to Brazil for consultative work. He also completed a trip to Mexico this fall, where he and his associates are developing manganese, iron and fluorspar properties.

Ernest Fraenkel was recently elected chairman of the board of directors of South American Minerals and Merchandise Corporation, New York exporting and importing representatives of the Hochschild interests in Peru, Bolivia, Chile, Argentina, and Brazil. Mr. Fraenkel has been with the company since it began in 1947 and formerly was with Watson Geach and Company, Inc. He succeeds **Paul Linz.**

Francisco Donis Ortiz, mining engineer for Nueva Montana Quijano, Santander, Spain, has been awarded the prize for the best metallurgical article in the recent contest sponsored by Mineria Y Metalurgia, publication of the Spanish mining engineers. In the mining division there were two winners, **Santiago Garcia Guente** and **Ramon Fernandez Soler.**

J. C. Nixon is new superintendent of metallurgical research for Consolidated Zinc, Ltd., Broken Hill, New South Wales, Australia. He previously was senior lecturer in ore dressing at the University of Melbourne.

John M. Russell is new field manager for the Nosterman Gold Mines, Ltd. and Bewick Moreing and Company, Kabale, Uganda, British East Africa. Mr. Russell, now prospecting for and developing tin and wolframite deposits, was formerly located at Kakamega, Kenya.

Dr. F. Meyer, chairman of the South African Iron and Steel Industrial Corporation, Ltd., recently made an extensive tour through the United States and Canada to study problems relating to development of the iron and steel industry. He observed labor-management problems, housing projects, and the general administration of industry in this country.

Paauvo V. Maijala, former superintendent of Outokumpu Oy S Ylojarvi Mine in Tampere, Finland, is now located in the Outokumpu Oy offices in Helsinki.

THEODORE KROLL and HECTOR ROBINET of the Societe Metallurgique de Hoboken in Belgium visited Australia recently. Among the operations they inspected were smelting and refining plants at Port Pirie, South Australia, and Port Kembla, New South Wales.

The Honorable J. G. Arthur, minister of mines, New South Wales State Department of Mines, recently toured major cities in the United States to seek technical information on U. S. mining and mining operations.

Fred E. Towsley, chief field geologist for the Kennecott Copper Corporation's South American division, is now in Lima, Peru. Mr. Towsley formerly worked in Colquiri, Oruro, Bolivia.

Kiichi Murakami, former chief engineer for the Sika Mining Company, Ltd., of Tokyo, Japan, is now adviser to the Sumitomo Metal Mining Company, Ltd., also of Tokyo.

K. L. Brindsden, general manager of the Croesus Proprietary Treatment Company, has moved from the firm's London office to Fimiston, Western Australia. Mr. Brindsden also serves as consultant to South Kalgurli Consolidated, Ltd., in Crawley, Western Australia.

Waldemar Zeidler is now a mining engineer for Svenska Skifferolje AB in Narkes Kvarntorp, Sweden. He formerly worked for V Sund in Nora, Sweden.

John C. Russell is the new chief research metallurgist for Rhodesian Anglo American, Ltd. at Kitwe, Northern Rhodesia. He has resigned from his position with the consulting engineering department of The Dorr Company at Stamford, Connecticut.

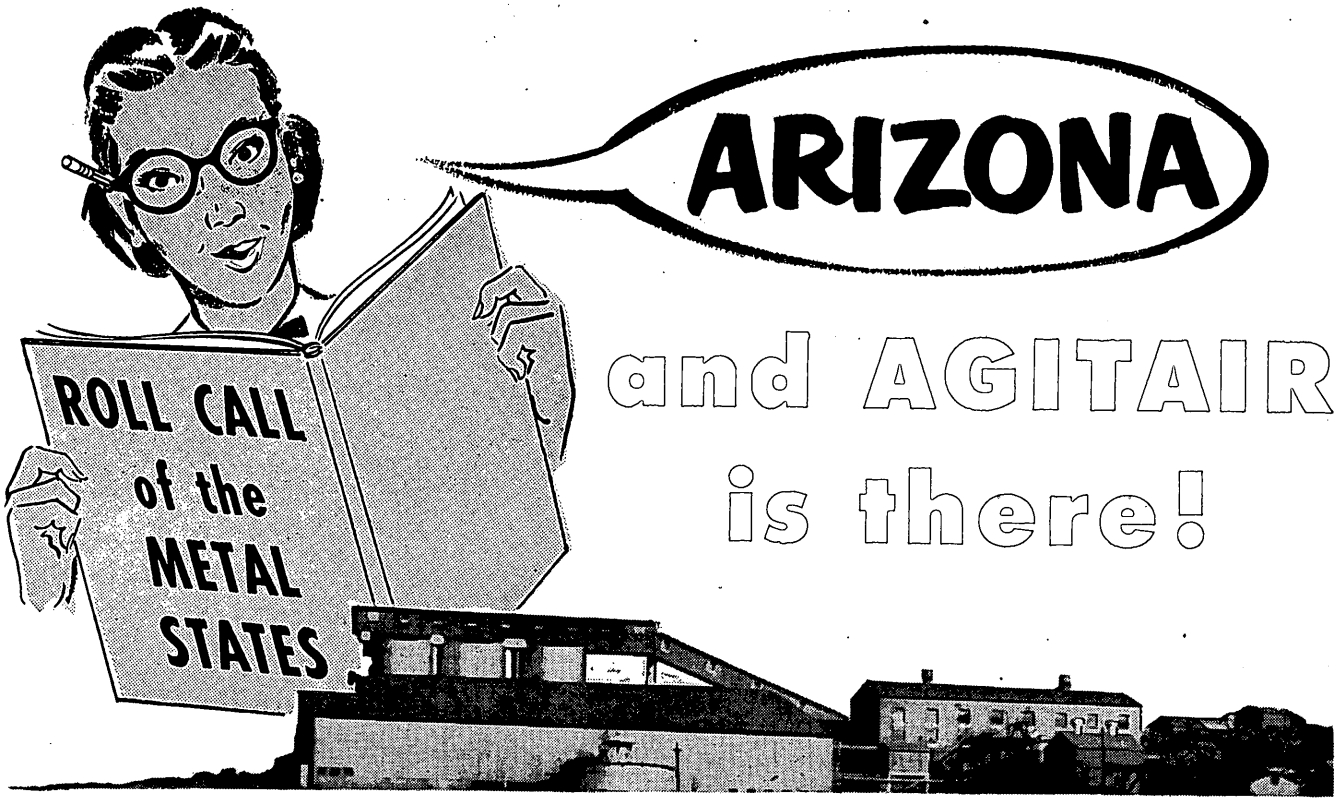
Colin York Syme is new chairman of directors of the Broken Hill Proprietary Company, Ltd., Melbourne, Australia. The 49-year-old executive, youngest man on the board, succeeds **Essington Lewis** who is retiring from active leadership of the board to assume an advisory capacity.

O. D. Niedermeyer has been appointed assistant general manager of the Nickel Processing Corporation at Nicaro, Cuba. The Nicaro operation is owned by the United States government, but National Lead Company has a majority interest. **John C. Archibald, Jr.** succeeds Mr. Niedermeyer as manager of the Texas Mining and Smelting Division of National Lead.

Harvey J. Hakala, former head of U. S. Steel Company's Brazilian subsidary, Companhia Meridional de Mineracao, has left the southerly manganese mining firm to resume his post in the mining engineering department of Oliver Iron Mining Division in Duluth, Minnesota.

Erik A. Schwalbe, employed by Stora Kopparbergs, Bergslag Aktiebolag, Blotberget, Sweden, has won a scholarship for six months' study in the United States on concentrating low-degree iron ore.

Per Gudmar Kihlstedt, former general superintendent of metallurgical operations for Bolidens Gruvaktiebolag, is a new professor of metallurgy at the Royal Institue of Technology in Stockholm, Sweden.



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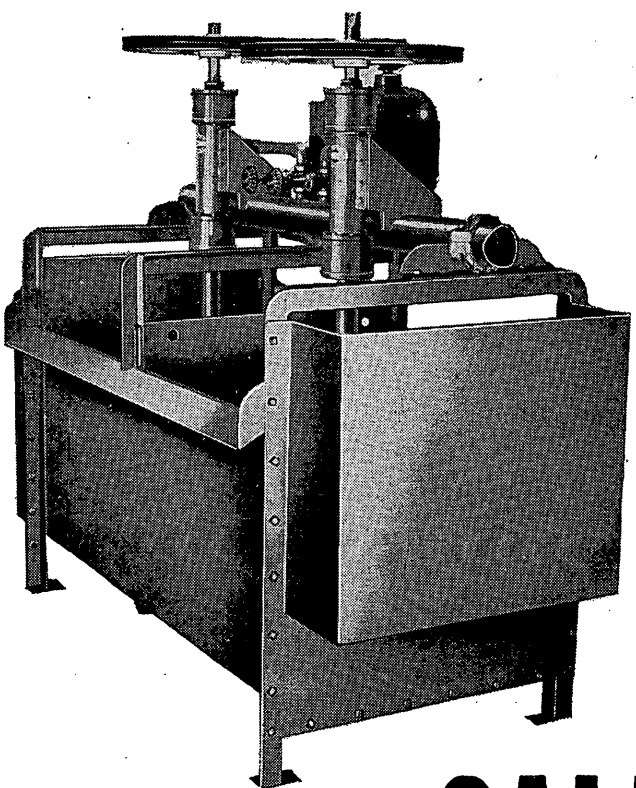

The plant shown above—located in Arizona—is a typical concentration mill, of 1500-ton daily capacity, with separate flow sheets for copper ore and copper-zinc ore. AGITAIR is used exclusively in this modern mill and is given large credit for a profitable operation.

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INTERNATIONAL NEWS

Glenn McCarthy To Operate Bolivian Sulphur Mines

Glenn McCarthy, famous Texas oil man, has signed a $3,000,000 investment contract with the Bolivian government for a sulphur mining concession in the Department of Potosi in southwestern Bolivia, just north of the Chilean border. Under terms of the concession, the Bolivian government will receive eight percent royalty on the gross value of exported sulphur.

According to reports, the new sulphur mining firm will not be required to give the Bolivian Banco Central the foreign currencies received for sulphur sales, nor will there be any limit upon quantities and destinations of exports. Initially, shipments are being made to Brazil at a price reported to be $140.00 per ton.

The concession is in one of the world's highest mining districts—5,970 meters or almost 20,000 feet altitude—where miners can only work four hours per day in the extreme cold and wind. Camp is at an elevation of about 5,000 meters (16,400 feet). Llamas are used to transport the sulphur from the mines to the camp where a small melting plant is operated.

Bagdad To Expand Mining And Milling Facilities

An $18,000,000 expansion program has been undertaken by the Bagdad Copper Company to increase mining and milling facilities at its properties in the Eureka mining district of Yavapai County, Arizona. Value of the metals extracted from the mines is expected to be increased from $6,200,000 during the past year, to $23,000,000 by 1954. Of this amount, $12,000,000 will be in copper, $1,000,000 in zinc, and $10,000,000 in tungsten ores.

The expenditures will be mainly for new equipment to handle increased production of copper, zinc, and tungsten. Two mines and their nearby mills are involved; one is at Bagdad where copper and small amounts of gold are open-pit mined, and the other is at Hillside where an old underground lead-zinc mine had been reopened as a tungsten mine.

A new housing project is now under construction, while improvements are under way on the 22-mile highway which links Bagdad and Hillside.

Agreement To Develop Canadian Asbestos Mine

An agreement providing for the completion of development of asbestos properties under Black Lake in Quebec, Canada, has been signed by United Asbestos Corporation Ltd. and Lake Asbestos of Quebec Limited, reportedly a wholly owned subsidiary of American Smelting and Refining Company.

The agreement grants to Lake Asbestos the right to examine United's property and operation, and to elect to equip the mine for production with a milling capacity of at least 4,000 tons of ore per day. Lake Asbestos will advance without any interest all funds for the purpose, and has already taken over all expenses in connection with operations of the property.

Monetary Fund Refuses To Act For Higher Gold Price

A move for a higher price for gold at the seventh annual meeting of the International Monetary Fund in Mexico City in September was headed by the delegation from the Union of South Africa and stoutly seconded by the Australian delegation.

Nicolaas Christiaan Havenga, Finance Minister for the Union, led the move. He argued that the time seems to be opportune for an increase in the price of gold and that many currencies now under pressure will be wrecked and with it the monetary mechanism unless gold is correctly priced.

Neither United States Secretary of the Treasury, John Snyder nor Sir Arthur Salter, British Minister of State for Economic Affairs, participated in discussions of the gold price nor in any part of the move to raise the official rate of $35.00 per ounce. Sir Arthur commented that the question would probably be considered at the Commonwealth Conference to be held in London in November.

The meeting took no definite action on the matter. The official answer was voiced by the Fund's director-manager Ivar Rooth. "Two Fund governors have spoken of the gold price. The executive directors and the personnel are convinced that this is an important question for the Fund, although there are differences of opinion about the matter, and therefore we consider it a matter that requires a more or less continued study. I can assure the governors that all points of view about this subject will be most carefully considered by the executive directors and the personnel."

The eighth annual convention is scheduled to be held in Washington, D. C.

Nicolaas Christiaan Havenga

Two Canadian Firms Agree To Provide Nickel for U.S.

Negotiations have been completed by the Defense Materials Procurement Agency with two Canadian mining firms to provide critically needed nickel for the United States.

One contract is with the East Rim Nickel Mines Limited of Toronto. The company has agreed to spend about $1,000,000 in partial development of its mines at Sudbury, Ontario, and to begin at once to mine and crush ore at a rate of not less than 3,500 short tons per month. The company has no processing facilities so, under a companion agreement, the Falconbridge Nickel Mines Ltd., also of Toronto, has agreed to process and refine the ore in its plants at Falconbridge, Ontario, and Kristiansand, Norway.

To assist in development of the Sudbury property and to augment U. S. supplies of nickel, the DMPA has agreed to purchase up to 65,000 short tons of ore. The East Rim deposit is estimated to contain over 2,000,000 tons of nickel sulphide ore.

O'okiep Copper Co. Signs Tungsten Contract with US

The O'okiep Copper Company Limited, operators of copper and tungsten mines in Cape Province, Union of South Africa, has signed a contract with the United States government for sale of all its tungsten concentrates until March 31, 1958. Under the terms of the contract, O'okiep is spending $500,000 to increase tungsten mining and concentrating facilities.

The new tungsten plant will have a capacity of 200 tons per day and will be built three miles from the copper mill. Tungsten will be recovered by tables.

The company reports a production of 47,243,000 pounds of copper for the year ended June 30, 1952, compared to 45,414,000 pounds in the previous year. Profits for the year increased to $9,374,610, compared to $5,721,946. The average price received for blister copper, largely sold in Europe, was 40.38 cents per pound. During the year, the company mined and concentrated 972,000 tons of 2.43 percent copper ore. Ore reserves were increased 30 percent last year by the discovery of the Vababeep orebody two miles west of the mine plant. They are now estimated at 17,410,000 tons of 2.43 percent copper. The Nababeep West orebody will be developed within the next five years at an estimated cost of $14,000,000. A new flotation mill may eventually be built to treat ore from this newly discovered orebody. A geophysical survey is now underway in the district to delimit indicated orebodies and to try to discover new ones.

The Newmont Mining Corporation owns 56.3 percent (575,103 shares) of O'okiep and values this stock at $25,879,365. On December 31, 1949, the stock was valued at $9,201,648.

PRODUCTION AT KILEMBE COPPER-COBALT MINE SCHEDULED TO START IN 1955

Kilembe Mines, Ltd., big copper-cobalt mine in Uganda, should be ready to start production in 1955, according to latest reports. It is understood that negotiations are nearing completion to provide the $16,500,000 needed to bring the mine into production. Meanwhile, stope development and other preparatory work is continuing, and production plant designs are being drafted.

Kilembe will begin producing at an initial rate of 2,000 tons per day, and is scheduled to produce 25,000,000 pounds of copper and 1,500,000 pounds of cobalt annually. This will rank the mine among the world's leading cobalt producers, and facilities are being designed for expansion.

Ore reserves are estimated at 15,000,000 tons with a cutoff grade of 2.0 percent copper and 0.16 percent cobalt.

When production begins, the deposits will be mined from both open pits and underground stopes. A main adit haulage level has been established at an elevation of 4,500 feet and other adits are portalled up to 5,000 feet in elevation. Ore will be transferred to the mill a mile away by surface railway, but it is anticipated that low level haulage will be established at the mill elevation.

A new, unique metallurgical process, approved by the Batelle Memorial Institute of Columbus, Ohio, has been developed to process the mine's ore. Some of the oxide ore will be concentrated and some will be mixed with the flotation concentrate to make a feed of 650 tons per day for the Dorrco fluosolid roasters. The soluble copper and cobalt oxides will then be leached from the roasted material, and electrolytic copper will be deposited from the solution. The high-grade cobalt oxide precipitate will be shipped to Wilmington, Delaware, where it will be refined into cobalt metal. The cost per pound of the copper is expected to be exceptionally low, particularly when credited with the value of the cobalt output. Gross revenue should be about $10,500,000 annually, and net profit $4,250,000.

A 208-mile railroad is being built to the mine by the Uganda government, and the Uganda Electricity Board will build a 240-mile power line to connect the mine with the new Nile River power development. An airport has already been built by the company, which is also continuing construction on a small 1,500-kva plant for use during the construction period and as a standby later. Contracts have been let by the government to rebuild roads to the mine.

AUSTRALIA—The prices of Government controlled copper, lead, and zinc rose during August and September. The new price is still below the cost of imported copper but will be most helpful to *Mount Lyell Mining and Railway Company, Ltd.* (Tasmania), and *Mount Morgan Limited* (Queensland). If the price does not fall, profits of *Mount Isa Mines Limited* (Queensland) will increase when copper production begins there next year. Australian copper output is still around 15,000 to 20,000 tons per year while consumption is about 45,000 to 50,000 tons anually. Lead and zinc prices were raised to £A 95 per ton (still considered ridiculously low by many in the field). This was an increase of £A 30 per ton. The increases affect Broken Hill (New South Wales) mining companies and the *Electrolytic Zinc Company of Australasia Limited* (Tasmania). These producers are now required to supply to the domestic market 50,000 tons of lead and 60,000 tons of zinc per year before disposing of their remaining production overseas at ruling rates (equivalent to £A 164 for lead and £A 153 for zinc). Price rises inside Australia do not affect *Mount Isa Mines Limited* (Queensland), *Lake George Mines Pty. Ltd.* (New South Wales), and other producers who already sell their output overseas.

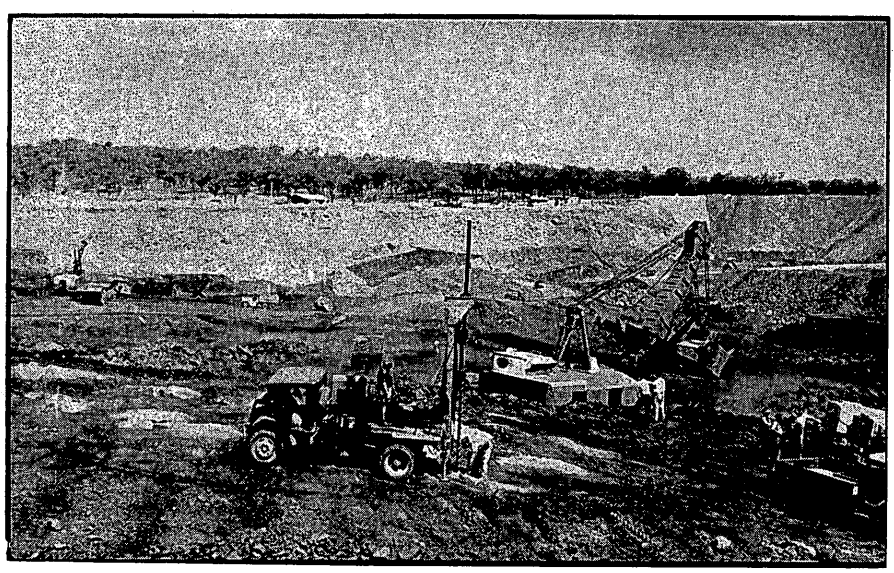
PHILIPPINE ISLANDS—For the first time since 1946-1947, base metal production for the fiscal year 1951-1952 consisting mostly of iron, copper, chromium, and manganese, surpassed gold and silver production by more than Pesos 9,000,000. The respective production figures are Pesos 53,340,000 for base metals and Pesos 44,240,000 for gold and silver. Base metals now constitute about 55 percent of metallic production and about 40 percent of total mineral production in the islands.

NEW SOUTH WALES—Milling has started at *New Broken Hill Consolidated Ltd.* at Broken Hill. Plant capacity is 350,000 tons per year and will be expanded as production increases.

TASMANIA—*Mount Lyell Mining and Railway Company Ltd.* will explore, systematically, the mineralized country southeast of the present mining area at Queenstown. Some of Australia's wildest country occurs in southwestern Tasmania. The Tasmanian prime minister says that a survey flight has indicated uranium in this sector, and that the government would build access roads to the area if uranium were found. The state government will also add £A 11,000 to the federal government's £A 25,000 reward for discovery. Geologists claim that the area will also yield rich deposits of copper, lead, and silver. Nickel has also been reported from this part of the island.

INDONESIA—Tin ore production reached a post-war record in July with 3,394 long tons, or 430 tons more than the June figure, and almost 750 tons higher than the average for the first six months.

SOUTH AUSTRALIA—A new railway will be built to link Radium Hill with Port Pirie, where a plant for extraction of uranium salts is to be erected with United States assistance. The plant will be operated by the *Broken Hill Associated Smelters Pty. Ltd.*, a company owned by Broken Hill, New South Wales, mining companies. Abandoned copper mines in the state are being prospected for possible uranium deposits. Formerly an important Australian copper producing state, South Australia has produced little of consequence in recent years.



DRILLING OVERBURDEN IN AUSTRALIA

The blast hole drilling undertaken by Theiss Bros., Proprietary Ltd. for open-cut mining at Muswellbrook, Australia, presented one difficult problem. Much of the vertical drilling of shot holes for removal of overburden would be through hard slate and conglomerate. In spite of the unusual conditions, the company is averaging 300 feet of 6- to 8-inch-diameter hole per day. Holes average 16 feet in depth, and in some cases drilling depths reach 46 feet. The equipment responsible for this accomplishment is the McCarthy Vertical Drill, manufactured by the Salem Tool Company of Salem, Ohio. Truck-mounted and adaptable for fast road travel, the drill pivots to a reclining position when the truck is on the move.

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WESTERN AUSTRALIA—*New Coolgardie Gold Mines N. L.* in four weeks to August 12, produced 2,420 ounces of gold from 4,924 tons of ore. The company recently reported development at its *Callion* mine of a 196-foot length assaying 33.8 dwts. over a width of 66 inches. *Kalgoorlie Southern Gold Mines N. L.* has obtained encouraging results in recent drilling. One hole was put down to 5,729 feet, believed to be a world record for an inclined hole. The trend of gold mining costs remains upward with profits declining. Both *Boulder Perseverance Ltd.* and *Gold Mines of Kalgoorlie (Aust.) Ltd.* recently reported reduced annual profits.

QUEENSLAND—Latest figures from *Mount Morgan Ltd.* (four weeks to August 24) show that 63,350 tons were mined and milled, averaging 0.105 ounces of gold per ton and 0.80 percent copper. Mill recovery was 4,360 ounces of gold and 434 tons of copper. Sale of pyrite from Mount Morgan's dumps is at £A 3 per ton at the railhead. Pyrite is also contained in overburden at the mine. It is railed to Cockle Creek, New South Wales, for acid manufacture and capacity for production may become 100,000 tons per year. Various projects are being considered for local utilization of the pyrite.

SOUTH AUSTRALIA—The Department of Mines is engaged in designing a plant for crushing and conveyor-belt transfers in dry-crushing plants.

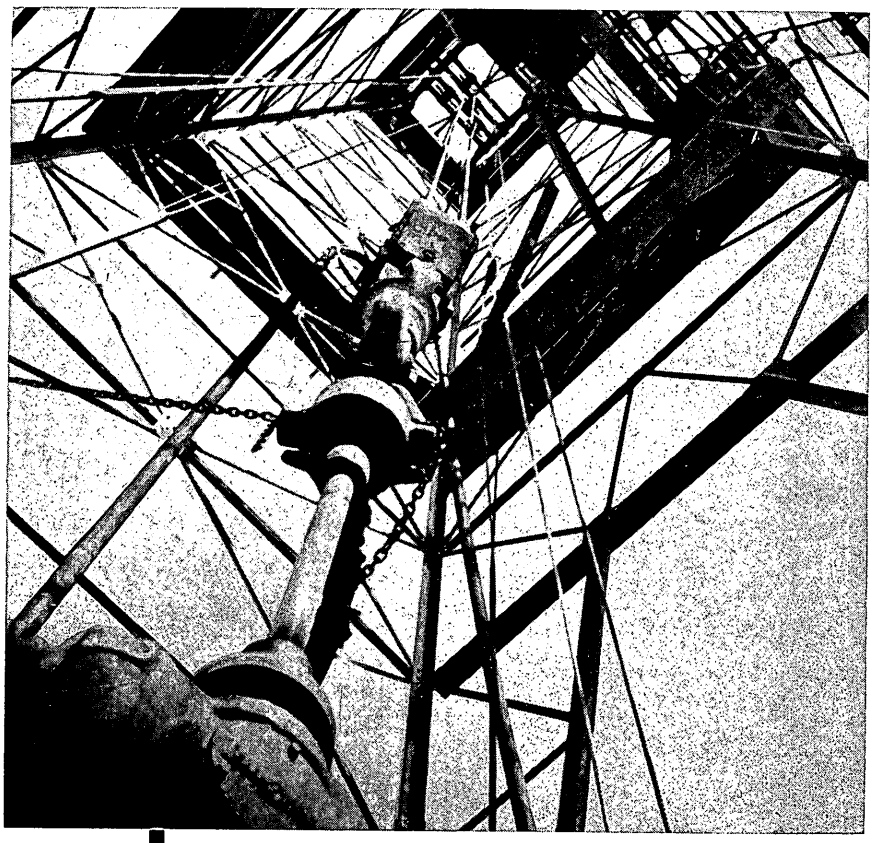
NEW ZEALAND—The *Otau* mine has supplied 500 tons of manganese ore for shipment to the United States. Previously, the ore had been going only to Australia. The Otau mine is thought to be the only manganese producer in New Zealand. It is located at the top of Ness Valley, 30 miles south of Auckland.

NORTHERN TERRITORY—*Peko (Tennant Creek) Gold Mines N.L.*, a small mining company on the Tennant Creek goldfield, has recently sent some sample shipments to the *Electrolytic Refining and Smelting Company of Australia Pty., Ltd.* at Port Kembla, New South Wales. The oxide ore carrying cuprite and metallic copper assayed 30 percent copper and 1.5 ounces of gold per ton. Sulphide copper ore assayed 28 percent copper and 1.0 ounces of gold per ton. Another small mine shipping copper ore over great distances to Port Kembla is that of *Home of Bullion Mines Pty., Ltd.*, which recently sent 500 tons assaying 16 to 20 percent copper. This ore is sulphide and the mining company plans to erect a small concentrator at Barrow Creek on the Alice Springs-Darwin highway, 140 miles south of Tennant Creek. The mill will permit treatment of 12 percent ore which at present is dumped. Ore from the *Nobles Nob* mine of *Australian Development, N.L.* at Tennant Creek, currently assays around two ounces of gold per ton. Monthly tonnage is 1,300 to 1,400.

PHILIPPINE ISLANDS—A 300,000 pesos loan from the Philippine Reconstruction Finance Corporation is being sought by the board of directors of *Demonstration Gold Mines, Ltd.* in order to step up rehabilitation of its mines in the Paracale district of Camarines Norte. The company needs additional funds to bring its *Santa Barbara* mines into milling operation. Unwatering of the mines has already been completed and some heavy machinery and equipment has been installed. Approval of the loan is awaited before the company can proceed with its rehabilitation work.

WESTERN AUSTRALIA—The second borehole sunk at the southern end of the Kalgoorlie field by *Kalgoorlie Southern Gold Mines N.L.* reached a depth of 5,700 feet. The first was sunk to 4,000 feet. At the *Blue Spec Mining Company N.L.* property, antimonial-gold concentrates are being shipped to the *Broken Hill Associated Smelters Pty. Ltd.* at Port Pirie in South Australia. *Anglo-Westralian Mining Pty. Ltd.*, which has interests in lead and gold-mining properties and which is itself 35 percent-owned by *Mount Isa Mines, Ltd.*, is reported to have inspected the Blue Spec property recently.

PHILIPPINE ISLANDS—A movement has been started to establish a bullion exchange in Manila for the purpose of trading in locally produced gold, and it is said to be gaining support from the various sections of the business community. Main purpose of the move is to stop a huge leak in the Philippine gold output through illegal exports abroad, and, at the same time, to save the local gold mining industry from possible collapse. Proponents of the plan believe that the operation of a gold bullion exchange will stimulate the mining industry through an increase in the free market price, and bolster the amount of U. S. dollars that will be made available to the Central Bank for financing imports.



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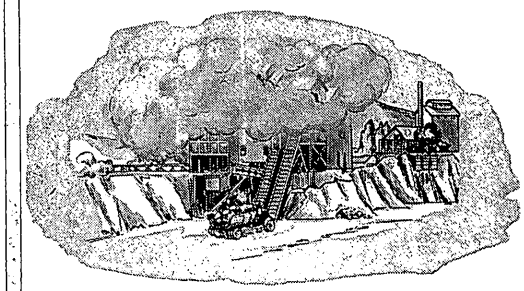
GEOLOGICAL INVESTIGATIONS

Laboratory Tests Help Quarry Operator Stop Dust Hazard

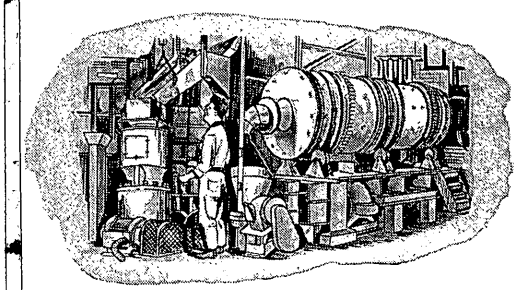
PROBLEM . . .

Dangerous silica dust was a health hazard to workers in a large eastern crushing plant. Minus 2-in. quartzite was being reduced by crushing and dry grinding to a size suitable for use in silica brick. The dust problem was acute.



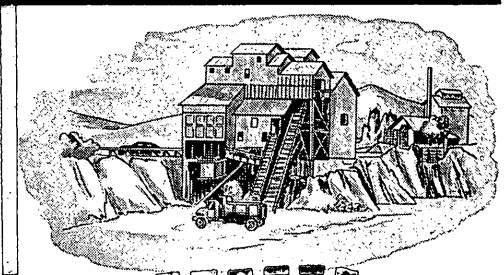
WHAT WAS DONE . . .

The problem was brought to the Allis-Chalmers Research Laboratory. A series of batch tests — followed by continuous pilot mill tests — showed that the specified size analysis could be obtained by wet grinding. A flowsheet was worked out in which the quartzite was crushed in a *Hydrocone* crusher, followed by wet grinding the crushed product in rod and ball mills and blending the mill products in the correct proportions.



RESULT . . .

Guided by these laboratory tests, this quarry operator set up a wet process which eliminated a hazardous dusting condition and still obtained the specified product.



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EUROPE

FINLAND—The government-owned *Otanmaki Company* is installing 12, 66-inch Fagergren flotation cells to remove sulphides from its magnetite-ilmenite ore. Development of the mine and mill construction are well-advanced, and first production of concentrate is scheduled for 1953. Plant capacity is scheduled for 500,000 tons per year, from which 175,000 tons of high-grade iron concentrate, 75,000 to 100,000 tons of 45 percent TiO_2 concentrate, and 5,000 tons of pyrite will be recovered.

ENGLAND—*Geevor Tin Mines Ltd.* will spend some £30,638 on a new electric hoist and equipment, new steel headframe, self-dumping skips, etc. which are to be delivered before the end of the year. In the 12 months ended in March, the mine produced 57,802 tons of ore which yielded 740 tons of black tin (65 percent Sn). The proceeds of this amounted to £414,668, compared with £423,566 yielded in the previous year for the same amount of tin.

WEST GERMANY—Plans are being made to open West Germany's first titanium deposit for commercial development. The deposit is located on the coast of Sylt Island in the North Sea, and is estimated to contain about 6,000 tons of titanium.

PORTUGAL—*Beralt Tin and Wolfram Limited* has concluded another price-fixed contract with the United States to supply about 2,500 long tons of wolfram concentrate over a five-year period beginning immediately. The company concluded another agreement last May to supply the U. S. with 1,000 short tons within two years at a fixed price. Beralt owns tin and tungsten properties at Panasqueira in the province of Beira Baixa.

SWEDEN—About 8,000 tons of Swedish iron ore arrived at *Bethlehem Steel Company's* Lackawanna plant in New York State recently. The ore is reportedly of the highest grade and is used extensively in Bethlehem's steelmaking processes.

CYPRUS—During the first six months of this year, exports of copper concentrates amounted to 47,750 tons—a monthly average of 7,958 tons, compared with 8,562 tons last year. Copper pyrite exports were much greater with a total of 61,282 tons during the six-month period, or a monthly average of 10,213 tons, compared with 8,255 tons last year.

AUSTRIA—The 1951 production of antimony almost met domestic requirements. This year's production is expected to rise about 15.6 percent, making it possible to export antimony for the first time. At the same time, the Austrian Ministry for Nationalized Enterprises has announced that the demand for x-ray-grade barium and for hard lead for use in batteries can be fully met by home production.

WEST GERMANY—*Stolberger Zinc Company* plans to develop a new lead and zinc prospect in the Kuferather Valley near Dueren. Between 500,000 and 750,000 tons of metal are estimated in the area, two-thirds of which is lead and the remainder zinc. A daily ore output of 2,000 to 3,000 tons is planned, with mining from open pits and some from existing underground installations.

AUSTRIA—The copper mines produced 59,723 metric tons during the first half of 1952. Compared with production during the same period of 1951 which was 38,451 tons, this represents an increase of 55.32 percent.

ITALY—The Official Gazette has published a special decree which authorizes the suspension of all duties on some ore flotation reagents which are not manufactured in Italy. Among them are "Activol 30," "Frother 60," "Aerofloat 15," pine oil, "Armac T," and others.

YUGOSLAVIA—The *Gutehoffnungshutte* of Oberhausen-Sterkrade (Germany) will plan and erect a copper and brass works in Yugoslavia which will be the largest and most modern of its kind in Europe. Included in the works will be a foundry equipped with modern electric melting furnaces.

EIRE—Shortage of money and the fall in base metal prices is blamed by *Silvermines Lead and Zinc Company, Ltd.* for its decision not to proceed further with the Russell shaft which has been concreted to a depth of 95 feet. Negotiations are still going on with the D.F.M.A. and it is hoped that the company's application for a loan of £37,500 will be approved shortly.

A Cost-cutting team

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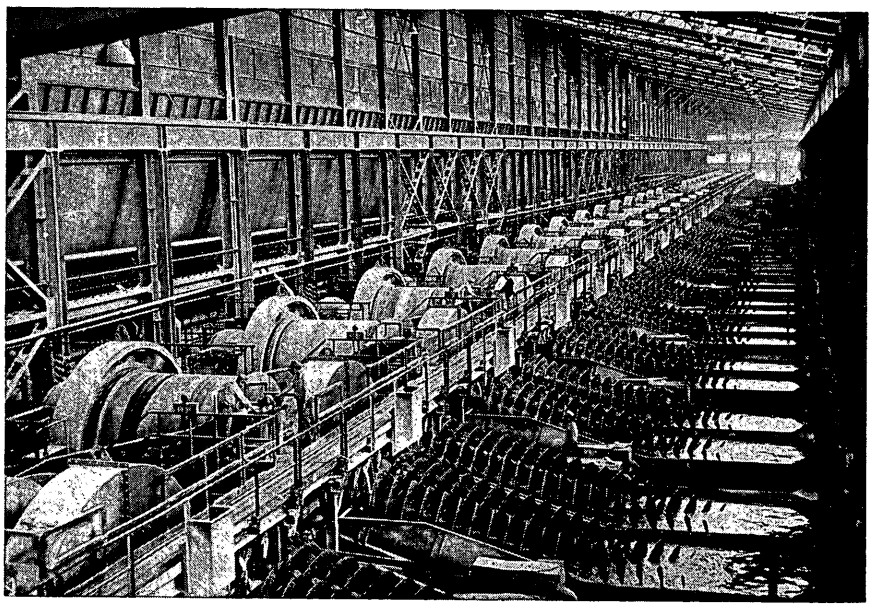

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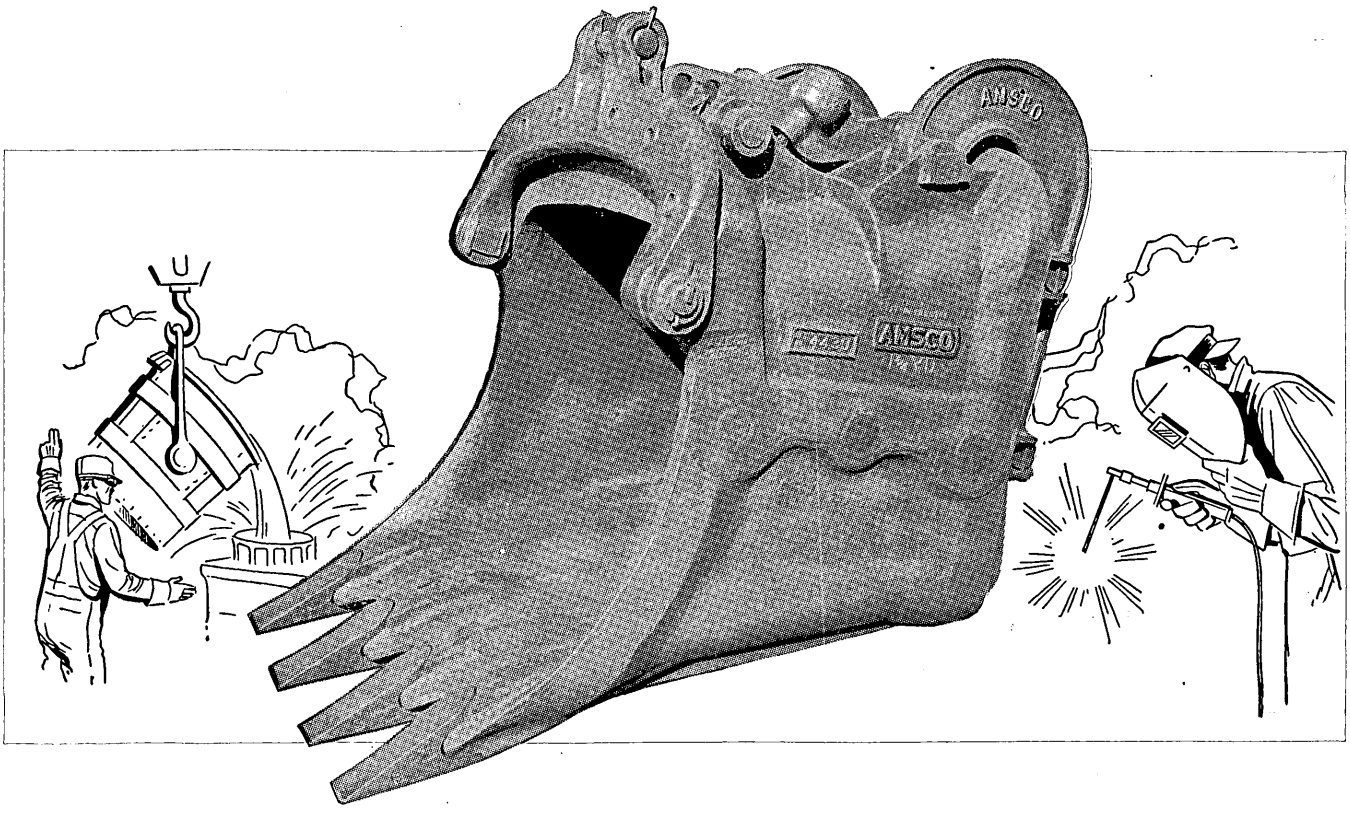

WHEN DIGGING'S TOUGH, THIS DIPPER'S TOUGHER

How service and manganese steel are cast and welded into **AMSCO** Dippers

More than 5,000,000 cubic yards of rock and abrasive materials have been dredged by one AMSCO All-Manganese Steel Dipper similar to this 1¾-yard model —and the end of its service is nowhere in sight!

Service like this is expected—and considered normal—by users of AMSCO Dippers. Just as users throughout all industry know that AMSCO Manganese Steel Products mean service and long life wherever impact and abrasion must be controlled. AMSCO Manganese Steel has the unique quality of actually becoming harder with use, acquiring a high surface polish to shrug off grinding abrasion, while retaining body metal toughness.

Made *entirely* of "The Toughest Steel Known," AMSCO Manganese Steel Dippers use no rivets, but are fabricated by the modern, streamlining Plug-Welding method that permanently interlocks cast segments. AMSCO All-Manganese Steel Dippers are available in two-piece welded, three-piece renewable lip, and Missabi designs—or can be adapted to your unusual materials handling specifications. Also available in sizes to fit all power shovels.

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- **Top and bottom have cast-in, double-wall box-sections for maximum strength, minimum weight.**
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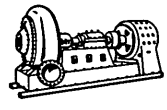
AMSCO controls impact and abrasive wear in 5 basic industrial operations:	Power Transmission	Mining and Excavating
Transportation	Crushing and Pulverizing	 Materials Handling

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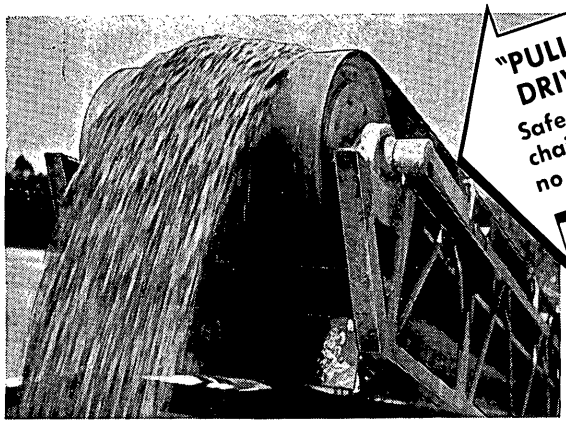

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Pulley shell of this revolutionary head pulley rotates around electric motor and reduction gears, which are held stationary by torque arm attached to conveyor frame. Quickly installed – requires no more room than idler pulley. All moving parts protected against weather, grit, dirt. Diameters 16" to 48". 5 to 75 hp. for voltages to 2300. Job proved.

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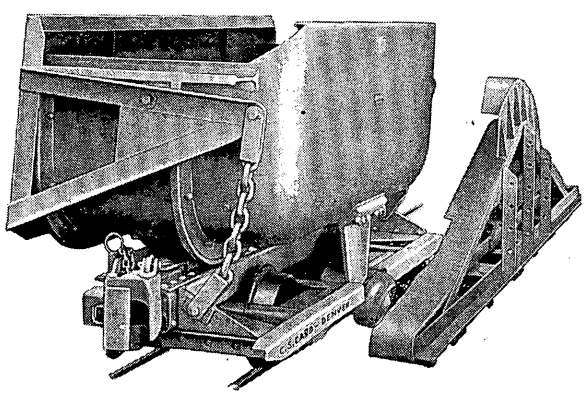

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SWEDEN—A large quartz deposit has been located at Prastehohesater, Rolanda parish, in southwestern Sweden. Quarrying will start as soon as possible.

WEST GERMANY—An ore deposit containing up to 66 percent uranium has been reported in the Black Forest by a German geologist. Further investigation will be necessary to determine whether mining operations would be practical. East German communists are said to be working mines which yield only 1.7 percent uranium ore.

EUROPE—American businessmen and firms planning to make new investments in 10 nations of Western Europe and Asia may now obtain a Mutual Security Agency guaranty protecting them against the risks of expropriation, as well as currency inconvertibility. The countries with which MSA has the necessary agreements are Austria, Belgium, China (Formosa), Denmark, France, the Federal Republic of Germany, Greece, Italy, Norway, and the Philippines. Convertibility guarantees are also available for new investments in The Netherlands, Turkey, and the United Kingdom.

NORWAY—*Undal* mine has been reopened after a shut-down of 30 years. The mine has now been dewatered and production will start as soon as the compressors are installed. The aerial tramway is now repaired, the new crushing machinery and the conveyors will be delivered shortly, and crushing operations will probably start in October. Production this year is expected to reach 5,000 tons and in 1953 20,000 tons. The ore is chalcopyrite, with about 10 percent copper and 40 percent sulphur. It will be exported through Trondheim harbor.

POLAND—It is reported that plans are under way for the erection of a huge iron and steel works near Cracow. A new city to house the workers will also be constructed, with both the plant and city to be named Nowa-Huta. An ore-treating mill, a sintering plant, a coke plant, blast furnaces, a power station, a series of rolling mills, and a number of repair workshops comprise the new works. Capacity is not revealed but it is estimated that it will be well in excess of 1,500,000 tons annually. The project is expected to be completed some time in the 1960's.

UNITED KINGDOM—There has been a temporary setback in barite mining. Stocks are high and many mines have not been able to dispose of their output. At the *Devonshire Baryta Company's* mine at Bridford, Devonshire, a number of men have been discharged and large stocks of barite are said to be awaiting shipment. In the north of England, *Silverband* mine has closed down, while at Cow Green 60 percent of the employes have been discharged. In Scotland, the tempo of barite mining has also slowed down, and in some of the fluorspar mines staffs have been reduced.

NORWAY—Extensions have been carried out at the *Falconbridge Nikkelverk* refining plant at Kristiansand, South Norway, which will enable the production of nickel to be increased to 14,000 tons a year. Norway's production of nickel last year was 11,080 tons. Nickel matte is imported from Falconbridge's smelter in Ontario, Canada.

WESTERN GERMANY—Uranium deposits have reportedly been found near Weissenstadt, and in the fluorspar mines of Woelsendorf and Nabburg. Some development work has been done at the Rudolfstein near Weissenstadt by *Maximilianshuette*, but no production has been reported so far.

SOUTH AFRICA—Exploration and drilling operations conducted by *Anglo-Rand Mining and Finance Corporation Ltd.* and *African American Gold and Mineral Exploration Ltd.* on a portion of the farm Vellefontein 1334, have resulted in the formation of the *Vellefontein Tin Mining Company Ltd.* Two-thirds of the share capital is owned by Anglo Rand and associated companies (including *Union Tin Mines Ltd.*) and the other third by African American. The new company has purchased the mineral rights over 1,313 morgen (about 2,772 acres) of the Vellefontein farm, which is situated in the Rooiberg area of the Transvaal. Mining operations have started, and in the initial stages ore will be treated in the plant of the Union Tin company. The capacity of Union Tin's plant was recently increased for this purpose. The area of the farm outside of the acquired mineral rights is held under option.

FRENCH EQUATORIAL AFRICA—By decree of the government of Dahomey, a mining permit granting exclusive development rights for its deposits of titanium has been given to the *Societe Miniere du Dahomey-Niger,* with headquarters at Zinder. The group is authorized to develop titanium deposits in northern Dahomey. The same group is already working a placer deposit on the Perma River, as well as in the Cercle de Natittingou, and tin and tungsten deposits in the Agades region of the Niger River.

SOUTH AFRICA—Formerly known as *New Reefs Gold Mining Company,* the *Zustershoek Tin Mining and Minerals Development Company, Ltd.* has now increased its capital to £100,000. Nearing completion is its treatment plant which will have an output capacity of 40 to 50 long tons of concentrates per month. The plant will be operated on a three-shift basis. An additional plant is already being ordered to increase capacity to about 100 tons within a year. Mining operations are in progress and a stockpile of hand-sorted ore is on hand which is expected to supply feed for nine months of milling.

GOLD COAST—*Bremang Gold Dredging Company* reports that for the period from January through May, 2,953,700 cubic yards were dredged, yielding 15,051 ounces of gold and an estimated operating profit of £68,900. These figures compare with 3,699,000 cubic yards, 16,775 ounces, and £90,564 profit for the corresponding period of last year. Most of the dredges have been working in the Offin and Jimi River areas. No. 2 dredge which was to be transferred to the Offin from the Ankobra River operation was delayed. However, investigation disclosed some payable values continuing in the area where it was already working so it was possible to keep the dredge in profitable operation for about nine months longer than originally planned. For the month of July, returns were as follows: No. 1 dredge treated 200,500 cubic yards and recovered 1,018 ounces of gold; No. 2 dredge, 66,900 cubic yards for 247 ounces; No. 3 dredge, 119,400 cubic yards for 780 ounces; No. 4 dredge, 199,000 cubic yards for 745 ounces.

NORTHERN RHODESIA—An area containing about 30,000,000 cubic feet of saw logs—enough to supply the copper mines with underground timbering for 15 years—has been located southwest of Chingola and west of Kitwe, according to the Northern Rhodesian Forestry Department. Arrangements are under way to begin cutting. Last year, 940,000 tons of wood were consumed and more than 29,000 acres were clear-felled. The copper mines have been cutting great quantities of wood fuel to supplement their insufficient supplies of coal. This was a temporary measure at first but now 80,000 acres of copperbelt woodland have been felled, and the forestry department is concerned about this continuing without any supervision. Reforestation and planting made some progress but did not catch up with the rate of cutting.

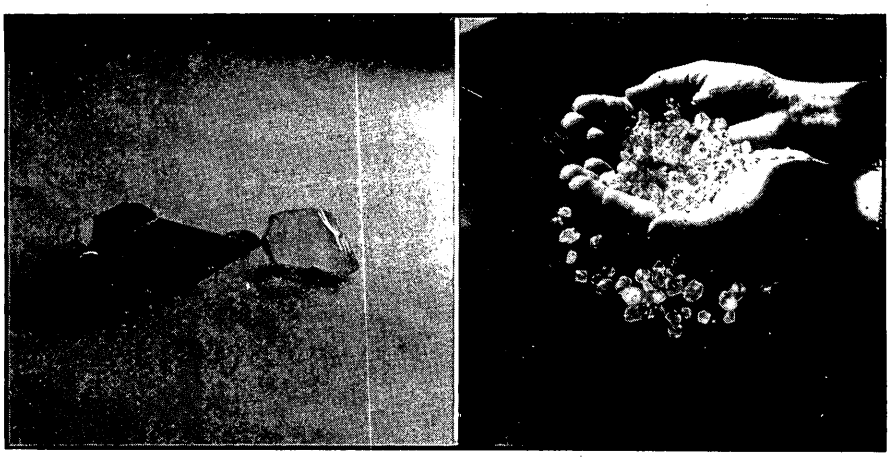
SOUTH AFRICA—The *Anglo American Corporation of South Africa, Ltd.* is reported to be taking a 75 percent interest in a monazite deposit in the Van Rhynsdorp district of Cape Province. The deposit has been drilled extensively. Planned annual production has been estimated at 8,000 tons of concentrate containing 55 percent of rare earths and thorium oxide. The right to mine and concentrate the ore and to export the products has been granted by the Minister of Mines on the recommendation of the Atomic Energy Board on the basis of an agreed royalty. All production for the period ending 31 March 1956 has reportedly been sold in advance, mainly to the United States. Discovery of the deposit is said to have started a rush to buy surrounding land. Some farmers are reported to be refusing to sell in the expectation of a higher price for their land.

FRENCH EQUATORIAL AFRICA—An interesting deposit of manganese has been located near Tiore. The manganese occurs in schists as pyrolusite (MnO_2). A minimum of 700,000 tons is said to be present with a grade of from 25 to 50 percent manganese. A group is being organized to develop the deposit.

NIGERIA—*Gold and Base Metal Mines* of Nyeba, Nigeria, reports that though tin production was slightly lower last year, this was offset by a higher production of columbite. Cost has risen seriously, to 33 percent over the previous year's total, chiefly through labor and royalty increases. The company is spending £50,000 to mechanize the mines as much as possible.

SOUTHERN RHODESIA—The long struggle over the control of *Tanganyika Concessions* is still unresolved. The various contesting share holders in Africa, Belgium, Great Britain, and the United States have agreed on a compromise and Sir Ulick Alexander has been elected chairman at the company's annual meeting in Salisbury. He succeeds Maurice Hely-Hutchinson who resigned last May. Sir Alexander will take up residence in Southern Rhodesia and will have to resign the chairmanships of the *Rhodesia-Katanga Company, Ltd., Tanganyika Holdings, Ltd.,* and the *Zambesia Exploring Company.*

NORTHERN RHODESIA—Additions are being made to the plant of *Rhodesia Copper Refineries Ltd.* at Nkana which, when completed, will enable vertically cast shapes to be produced, probably during the first half of 1953. Extensions were made to the plant during the last fiscal year which brought the capacity up to 124,000 long tons annually. However, the continued shortage of coal rendered it impossible to obtain the power required for full production.



DIAMONDS GALORE FROM THE PREMIER

Diamonds of all sizes and shapes are produced at the Premier mine at Kimberley in the Union of South Africa. The largest diamond ever found there was the "Cullinan Diamond" which weighed 3,024.75 carats. The "Great Premier Mine Diamond," discovered in 1951 (shown above left), was 2½ by 1½ by ⅝ inches in size and weighed 283.5 carats. Its value was estimated at between $280,000 and $560,000. Believed to be only about one-half of a larger stone, it is hoped that the other part will be recovered eventually. The handful of diamonds (right) are valued at between $56,000 and $84,000, and also came from the mine, which is operated by the Permier Premier (Transvaal) Diamond Mining Company, Ltd. De Beers Consolidated Mines, Ltd. owns a controlling interest.

On Ozark-Mahoning Company Fluorspar Mining Operations

There's no waste of valuable fluorspar ore at the Roseclare concentrating plant of the Ozark-Mahoning Company. Scattered remains of ore stockpiles, that could not be picked up with the loading shovel, are salvaged by an HT4 TRAXCAVATOR Shovel-"Cat" D4 Tractor team.

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ONTARIO—Iron ore output at *Steep Rock Iron Mines, Ltd.* for the first 15 days of September set new records. Total shipments from the *Errington* open pit reached 154,300 tons for the period, an average of 11,021 tons per working day. The number of railroad cars loaded reached 2,740, or an average of 196 each working day. Steep Rock ore has been moving down the Great Lakes at an average rate of better than one shipload each day. During the first half of the month, 22 ships were loaded at Port Arthur ore docks.

ALBERTA—In an all-out effort to have the new $17,500,000 nickel refinery of *Sherritt Gordon Mines, Ltd.* ready for operation in 1954, construction crews are working double shifts six days a week. The project is near Fort Saskatchewan, about 18 miles northwest of Edmonton. A railroad line will be built to the plant site to carry ore from the mines at Lynn Lake in northern Manitoba. *Chemical Construction Company* has the over-all contract to build the refinery.

GREENLAND—A new company, *Nordic Mining Company Ltd.*, reportedly has been formed to undertake lead mining at Mestersvig in East Greenland. It has an initial capital of 15,000,000 Danish kroner, 27½ percent of which is subscribed by the Danish government, 27½ percent by Danish companies, and the remainder by Swedish and Canadian interests. Further investigations are being undertaken before mining operations start.

BRITISH COLUMBIA—*Reeves MacDonald Mines Ltd.* is constructing an underground hoist room preparatory to sinking an inclined shaft along the footwall of the Reeves orebody. Sinking is scheduled to start soon. The firm reports a milling average of 27,500 tons of zinc-lead ore monthly so far this year. A new jaw crusher is expected to increase this output to about 30,000 tons per month.

ARIZONA—*Bagdad Copper Corporation* has undertaken an $18,000,000 expansion program in the Eureka mining district of Yavapai County to increase mining and milling activity over the next two years. Value of the metals extracted from the mines reportedly will increase from $6,200,000 during the past year, to $23,000,000 by 1954. Of this amount, $12,000,000 will be in copper, $1,000,000 in zinc, and $10,000,000 in tungsten ores.

ONTARIO—The Canadian National Railway is at work on a 600-foot extension to its iron ore loading dock at Port Arthur. The new addition will double the length and the capacity of the dock (now 30,000 tons) and is expected to be completed for the 1953 season.

SASKATCHEWAN—*Anglo Rouyn Mines Ltd.* reports gold and copper values in assay results as it continues its vigorous drilling program to explore the "A" zone of the Waden Lake property in northern Saskatchewan.

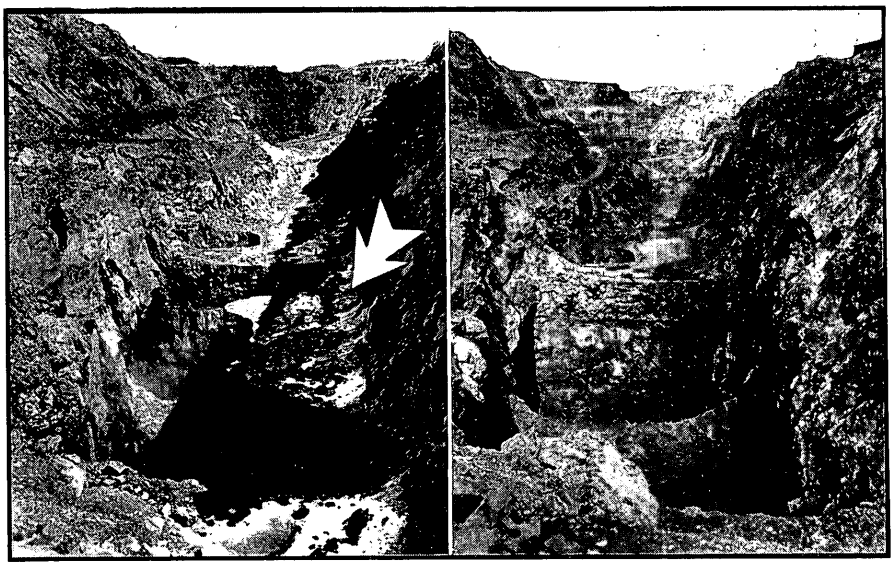
NORTHWEST TERRITORIES—*American Yellowknife Mines Ltd.* has started a second shaft sinking operation, this time at a subsidiary, *Snare River Mines,* where diamond drilling earlier indicated 50,000 tons of ore averaging 0.551 ounces of gold per ton to a depth of 275 feet. At the O'Connor Lake property, the shaft has now been collared and the headframe is being erected. The No. 1 vein is to be developed at the 150-foot level. Drilling results indicate the vein contains 250 tons of ore per vertical foot, averaging 18 percent combined lead and zinc. J. C. Byrne is president of American Yellowknife.

QUEBEC—*Eastern Metals Corporation Ltd.* reports rapid progress is being made at its nickel-copper property near St. Fabien de Panet. The mine shaft has been collared, and sunk 35 feet, and the headframe is now being erected. The combination mine dry, warehouse, and office is about two-thirds completed. The surface drilling has had to be stopped twice for cementing due to caving. The exploratory diamond drill, working about 2,400 feet from the shaft area, continues to cut copper values of high-grade ore over a narrow width ranging from 1.5 feet to 5.0 feet.

BRITISH COLUMBIA—*Violamac Mines Ltd.* plans to build a 150-ton mill for its lead-zinc-silver mine which would replace the present 30-ton mill now in use.

MICHIGAN—*Inland Steel Company* plans to give its 20,000 employes an opportunity to purchase company stock. Included in the group are employes from the *Greenwood* and *Morris* mines and the general office. Employes will be offered options on stock equal in value to 25 percent of their 1951 earnings from the company at $42.25 a share, which is 95 percent of the closing price for the stock on the New York Stock Exchange on August 25th. The options may be exercised at any time after one year and within three years.

ONTARIO—Production from the *Moulton Hill* and *Suffield* mines of *Ascot Metals Corporation,* before deductions, totaled $322,757 during August, when production included 190,542 pounds of copper, 302,268 pounds of lead, 1,226,926 pounds of zinc, 28,169 ounces of silver, and 321.6 ounces of gold. Lateral development on the 9th level of the Moulton Hill is continuing to open good ore with over 500 feet of length drifted out. On the 10th level (bottom), drifting has been temporarily halted in order to concentrate on mining on this horizon because during the next shaft sinking program all work on the level will have to be stopped until the shaft is completed. Raises currently being driven from the 10th to the 9th level are reported to be opening good widths with grade comparable to that exposed in drifting and mining on the 9th. On the new 3rd level of the Suffield, the crosscut is also making satisfactory progress. Original drilling indicated the drive would intersect ore about 600 feet from the shaft. Sampling of the last few faces, however, returned values close to ore grade, and the structural conditions indicate that the crosscut might hit ore at any time. From the 2nd level, flat drilling in the north drift is continuing to lengthen the ore to be anticipated between the 2nd and 3rd levels. Exploration on the 4th level will start soon.



INCO CONVERTS OPEN-PIT OPERATION

The "before and after" photographs shown above were taken from the south ramp of the Frood pit of The International Nickel Company of Canada, Ltd. in the Sudbury district of northern Ontario. A section of the footwall containing 225,000 tons of ore (marked by arrow in the lefthand picture) was blasted recently, leaving the gaping hole in the righthand picture. The ore dropped to the 600-foot level of the underground mine. Size of the area where the underground operations have holed through to the pit is 220 feet wide by 350 feet long. The operation was part of Inco's $150,000,000 program of conversion from combined surface and underground mining to all-underground mining. Without let-up in its present schedule, Inco has greatly enlarged its underground operations. Whole new areas have been developed for ore production, more than 70 miles of new underground openings have been driven in solid rock, four new concrete-lined shafts have been sunk, and much new equipment has been installed. Scheduled for completion next year, the company will then be able to hoist 13,000,000 tons of nickel-bearing ore per year.

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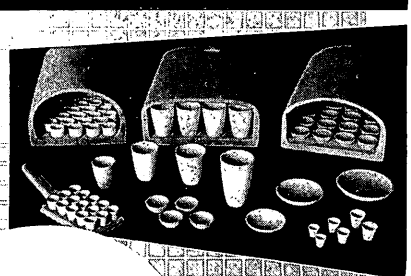

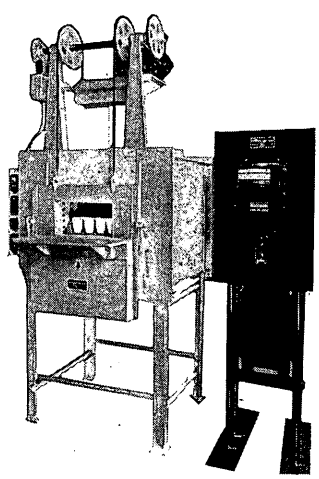

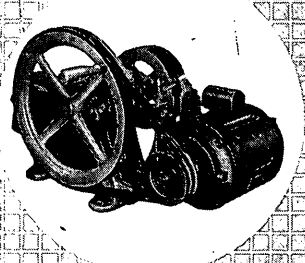

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ONTARIO—*Yukore Mines Limited* has acquired a one-third interest in 15 iron claims in Boston Township near Larder Lake, Ontario. A diamond drilling program has started after initial exploration. Camp buildings are being erected and two months' supplies have been hauled in.

NORTHWEST TERRITORIES—*Salmita Consolidated Mines Ltd.* is attempting to completely winterize its mining camp on the shores of Matthews Lake, 150 airline miles northeast of Yellowknife. Two, 250-hp., Paxman Diesel-electric units are being installed as a preliminary power plant, and the winterizing project is based on using part of this power for heat. In previous years, work has been suspended at Salmita during the winter.

SASKATCHEWAN—*Gunnar Gold Mines Ltd. and Associates* report that they have made a uranium discovery on the north shore of Lake Athabaska. The zone appears to be 450 to 500 feet wide, according to reports, and the area of radioactivity extends for a length of over 1,000 feet. The deposit is said to be something new in Canadian uranium mining experience in that it is massive in character and appears to be of a limestone or marble appearance. No blasting will be attempted until a scintillometer survey is made as a guide to further work.

ONTARIO—Although *Buffalo Ankerite Gold Mines* is currently treating in excess of 300 tons of ore daily at its *Porcupine* mine, President F. R. Burton reports that unless substantial higher grade ore bodies are discovered in the near future the mine will be placed on a salvage basis. This would mean that only such ore as will definitely show a profit will be extracted and milled. An extensive exploration and development program, incorporating all of the ideas of the company's staff and of a firm of independent engineers, has located only a few small ore bodies of insufficient tonnage. Operations in the past few months have been at a loss.

NORTHWEST TERRITORIES—*Indore Gold Mines Ltd.* has decided to enlarge its milling plant from 20 tons to 50 tons per day as the result of a discovery of two more radioactive zones on its property holdings in the Hottah Lake area. Indore's resident engineer Frank W. Anderson reports that one of the new zones will more than double the "Pitch 8" ore reserves already valued at $4,350,000. The other major discovery of radioactive material is located at Indore's "Pitch 27-28" property.

MICHIGAN—Work on the *White Pine* copper mine project is proceeding rapidly. Headway is being made at the mine site, town site, and residential sections. Most of the 100 acres needed have been cleared and leveled. Work has started on the 14-mile railway extension from Bergland, and on various buildings and plants. Concrete pouring for the 35-foot portal tunnel has also begun. A daily ore production of 10,500 tons is planned when the project is completed.

NORTHWEST TERRITORIES—The first two holes completed below the 5th level at *Tungsten Corporation of Canada Ltd.'s Outpost Island* property intersected gold values, officials report. Hole No. 1 is said to have returned 0.46 ounces, and 0.62 percent copper across 4.0 feet, and hole No. 2 cut 4.38 ounces of gold over 5.5 feet. Assays are awaited on five additional holes. Work is also scheduled to begin on the optioned *Otto* group in the Yellowknife district.

BRITISH COLUMBIA—Exploration and development have started on a new

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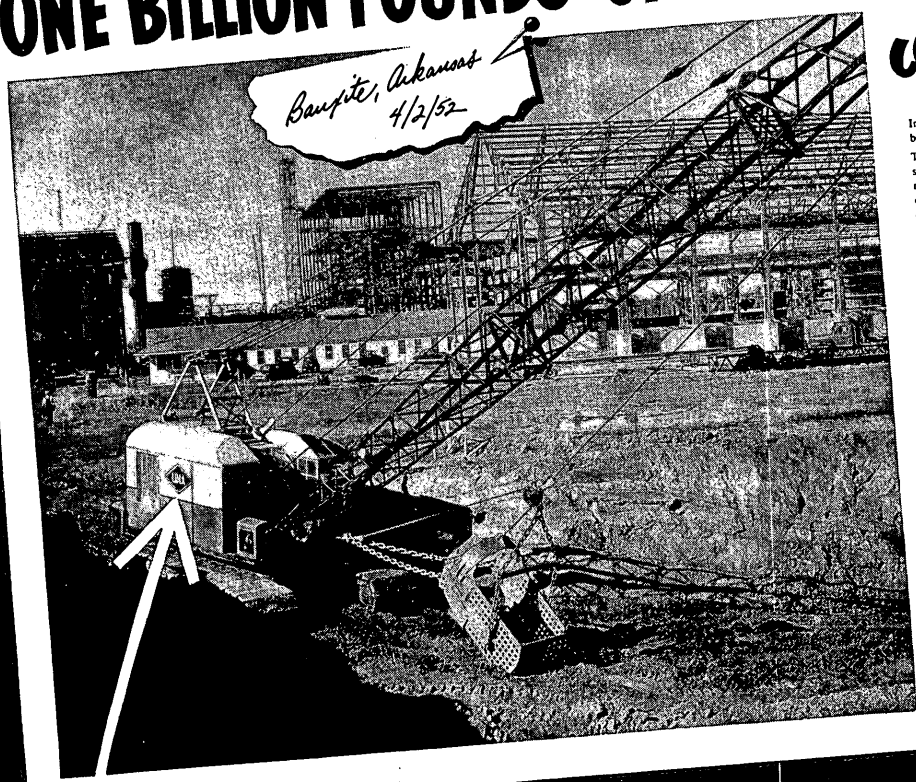

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property acquired by *Sheep Creek Gold Mines, Ltd.* in the Lardeau mining district, about 40 miles north of the head of Kootenay Lake. The property includes 78 claims and represents a consolidation of the *Wargner Jewell, Abbott,* and *Bannockburn* groups. It is now known as the *Wagner* property. A mining camp is being constructed and preparations for surface trenching are in progress. Former operators drove a 140-foot tunnel on the vein and sank a 60-foot winze, exposing lead-silver-zinc ore. A new tunnel will be driven under the structure for at least 2,000 feet.

ALASKA—The *Ebner Gold Mining Company* has reportedly sold its entire stock to the *Alaska Juneau Gold Mining Company.* Nineteen patented lode claims and 216 acres, but no developed ore reserves, are said to have been involved in the transaction. Acquisition of the property is expected to eliminate any possible disputes over apex rights in the future, when Alaska Juneau resumes mining on the lower levels. It has been closed since 1944.

WASHINGTON, D. C.—Dependence upon foreign kyanite for the United States defense program is being rapidly removed through the increased production of synthetic kyanite. The kyanite and mullite industry in the United States is now producing approximately 46,000 short tons a year, with synthetic kyanite accounting for about 18,000 tons. This represents an increase of about 16,000 tons over the synthetic kyanite produced at the start of the defense mobilization program. This synthetic production, plus about 20,000 tons of domestic kyanite mined annually, should soon equal total demand for kyanite and mullite by American industry.

MANITOBA—*American Smelting and Refining Company* is diamond drilling in the Lynn Lake area north of *Sherritt Gordon* property. The firm is exploring the *Goodenough* property originally drilled several years ago. At that time, all 12 holes drilled cut pyrrhotite, magnetite, and some chalcopyrite. There are about 50 claims reportedly in the group, including a part of Barbara Lake.

ONTARIO—*Steep Rock Iron Mines, Ltd.* is pushing seven headings on a three-shift-per-day basis in its initial underground program at the *Errington* mine. The new Errington underground plant is highly streamlined and total investment involved was about $5,000,000. Increased mechanization and use of block caving are expected to reduce mining costs. The initial shaft is designed for a production of 5,000 tons of ore daily.

SASKATCHEWAN—Intensive exploration is under way to determine the potential of the properties held by *Goldfields Uranium Mines Limited* at Lake Athabaska. Drills are active on four claim groups; in other sections of the property, crews are at work taking magnetometer readings and preparing for further assessment work where radioactive showings have been indicated in previous surveys.

ONTARIO—*Canadian-Cliffs, Ltd.,* the wholly owned subsidiary of *Cleveland-Cliffs Iron Company,* is actively engaged in exploration and examination of iron ore prospects on both private and crown lands in New Brunswick, Quebec, and Northwestern Ontario.

BRITISH COLUMBIA—A $3,000,000 development program will be undertaken by *American Metal Company, Ltd.* of New York on the *Salmo Prince* silver-lead-zinc property, owned by *Salmo Prince Mines, Ltd. Amco Exploration*

WORLD MINING

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Ltd., a wholly owned subsidiary of American Metal, will be in charge of the work. Salmo Prince will retain a substantial interest in earnings on a royalty basis. It will also continue as an active company in the exploration and development field. Recent reports of tungsten showings in the South Okanagan district will be explored by Salmo Prince. These tungsten claims, nine miles west of Oliver, were originally staked as a gold prospect.

NORTHWEST TERRITORIES—Shaft sinking is expected to be resumed at the property of *Bulldog Yellowknife Gold Mines* at Matthew Lake about 150 miles northeast of Yellowknife. The company has been working on installation of a power plant, compressor and hoist. The three-compartment shaft has been completed to a 38-foot depth. It will open two levels, one at 200 feet and the other at 400 feet.

NEWFOUNDLAND—*Independent Mining Corporation* is proceeding with an underground development program at its *York Harbor* base metal property after favorable results from recent diamond drilling. The old mine workings, located on the side of a hill, will be extended southward by a long adit which will be driven at least 2,000 feet making two ore lenses accessible for mining. A contract has been let for this work. Mining plant and equipment have been ordered, with the expectation that driving may be finished by February. The provincial government has agreed to proceed with construction of a 14-mile road to the mine from Benoits Cove, with the understanding that the company will repay a portion of the cost if profitable production is achieved. Informal discussions have been held with officials of the *Newfoundland Power and Light Company* to deliver 3,000 hp. to the mine.

YUKON TERRITORY—*American Metal Company, Ltd.*, through its wholly owned subsidiary, *Amco Exploration, Ltd.*, has reportedly signed an agreement with *Mount Keno Mines, Ltd.*, to provide $200,000 and up to $3,000,000 for development of high-grade silver lead property on the south slope of Keno Hill.

ONTARIO—One of the largest nickel-copper ore bodies in recent Canadian mine development has reportedly been established by *Falconbridge Nickel Mines, Ltd.* in one small sector of the Sudbury Basin's north rim. The major extension of indicated ore reserves has been achieved in the Fecunis Lake drilling midway along the "Levack belt."

BRITISH COLUMBIA—*Canadian Exploration Ltd.* reports that its Jersey lead-zinc mill handled 155,274 short tons of ore and produced 18,948 tons of concentrates in the six-month period ending June 30. Net profit for the period is estimated at $1,940,000. Capacity of the mill is to be increased to 35,000 tons monthly by the end of the year.

BRITISH COLUMBIA—The *United States Smelting, Refining and Mining Company* of Boston, Massachusetts, has been registered in British Columbia recently to carry on exploration and development of natural resources.

MEXICO—General A. Morales Salas and Joseph Wekstein have been awarded the concession to develop rich sulphur deposits on the uninhabitated island of Socorro, 369 miles off the coast of northwest Mexico. Various surveys have estimated the deposits at 800,000 tons or more with an average purity of 95 percent. Several United States mining companies have attempted to get the concession. The Mexican group reportedly plan to spend $827,000 on the operation. They will build a refinery on the island and hope to produce 200 tons of refined sulphur daily within nine months to a year.

CUBA—The *Nicaro* nickel plant in Oriente Province is now in full operation. Recent production figures reportedly indicate that the plant has met the goal of higher efficiency by producing nickel in greater quantities than it did during its wartime operations. Nicaro was built by the United States government at a cost of $32,000,000. It produced 63,500,000 pounds of nickel before its shutdown in 1947. Rehabilitation, begun in 1951, cost about $12,000,000. The projected goal is 3,000,000 pounds of nickel annually.

BOLIVIA—It is reported that a group of Argentinians headed by Selim Chacur have made an agreement with the Bolivian government to erect a tin smelter and other industrial plants in Bolivia. Bolivia reportedly will supply 51 percent of the authorized capital ($220,000,000), while the Argentine group will supply 49 percent. Among other things, the agreement is said to grant a 25-year monopoly on tin smelting. The government is particularly interested in becoming independent of the various tin smelters in other parts of the world which might refuse to buy Bolivian tin ores or might raise the penalties for impurities if nationalization of the mines goes through without adequate compensation.

MEXICO—*Minas de Guatano*, S. A. is installing a new 36-inch Wemco classifier in its zinc-lead mill in Sonora.

CUBA—The Director of Mines of the Agriculture Department inspected the *Florencia* copper and gold mine in the Guaimaro district of Camaguey and indicated that the mine had good showings. The ore reportedly has yielded half an ounce of gold to the ton.

BRITISH GUIANA—The manganese deposits of *Barima Gold Mining Company (Canada) Ltd.* are being explored by a mining company from the United States which is said to be interested in the property. This company (name not revealed) has been granted a two-year option, and promises to spend $100,000 on exploration.

MEXICO—The Republic Steel Company (a U.S. firm) is reportedly planning to invest 80,000,000 pesos ($9,250,000) in the development of iron deposits at Tapatila near Jalapa, Vera Cruz. The work is scheduled to start this fall, according to Marco Antonio Munoz, governor of Vera Cruz. Special facilities have been granted to Republic by the Vera Cruz and Federal governments for the operation.

BOLIVIA—*Cia. American Smelting Boliviana Ltd.* announced some time ago that it was closing its *Corocoro* copper mine. Now the company is being accused of sabotage because it is withdrawing its trucks and materials.

JAMAICA—A geological survey is being made of an iron ore deposit on the island which is reported to occur in sufficient quantities to make shipments to Canada and the United States a practical possibility.

BRITISH GUIANA—*African Manganese Company Ltd.* is conducting an independent survey for manganese. First area to receive attention is at Arakaka in the northwest district. African Manganese has extensive manganese holdings in West Africa.

MEXICO—*Fundidora de Fierro y Acero de Monterey*, S.A., Mexico's largest iron and steel works, has notified the Federal Board of Conciliation and Arbitration that it will close its *Golondrinas* iron mine in northern Nuevo Leon because of exhaustion of ore after 50 years of operation. The 200 miners will be fully compensated in cash as provided by law. Fundidora has arranged to work iron deposits in other parts of Mexico.

MEXICO—*Compania Minera Santa Maria del Oro*, S.A., wholly owned subsidiary of the *International Mining Corporation*, reports that for the six months ended June 30, 1952, the company milled approximately 84,050 dry metric tons of ore of an average grade of 11.37 grams of gold and 0.972 percent of copper. After provision for depreciation, depletion, amortization, and income taxes, the company showed a loss of $5,168,89 for the six months. A substantial part of

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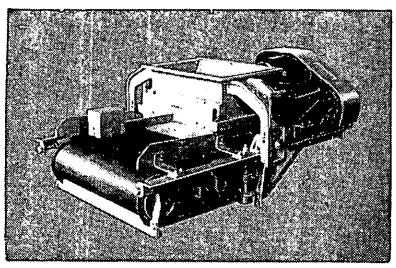

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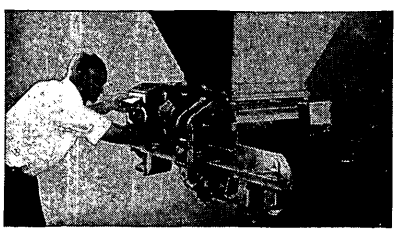

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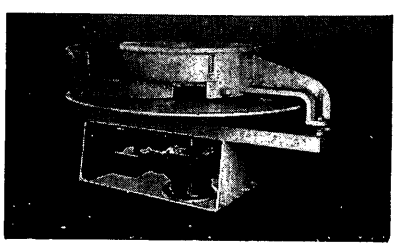

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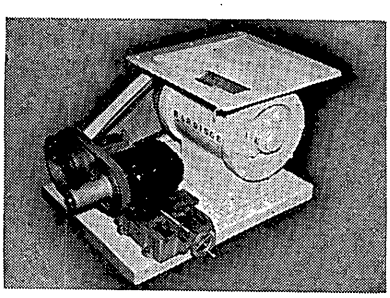

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the mine operation expenses represented development expenditure which may be capitalized later in the year if development work adds materially to the ore reserves.

NICARAGUA—*La Luz Mines, Ltd.* reports a sharp increase in profits for the nine months ended June 30, 1952. Operating profits totaled $546,667 compared with $275,027 for the same period in 1951. Principal reason for the increase was the larger tonnage milled—518,589 tons against 459,994 tons in the previous year. Gold output rose 14,106 ounces to 56,555 ounces. Deepening of the main shaft started in the June quarter and sinking of 80 feet had been accomplished by the end of June. During that period, the height of the Mistrook water storage dam was increased an additional five feet making a total height of 65 feet. This adds to the company storage facilities considerably.

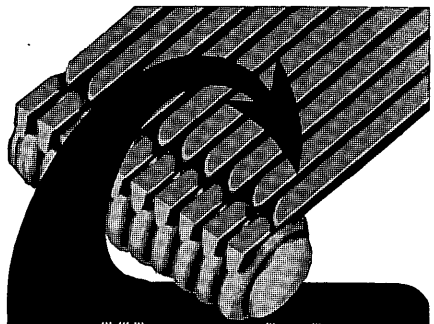
CUBA—Large deposits of iron pyrite are reported to be present in the *Margot* mine near Corral Nuevo, province of Matanzas. The Commission on Mine Investigations of the Ministry of Agriculture will inspect the property. It is also reported that a uranium mine has been located in the district of Sr. Maria Ana Salas de Garcia.

BRAZIL—Two hydroelectric projects have been set up in the state of Minas Gerais under a modernized power development program expected to stimulate mining and manufacturing in the state. *Companhia de Electricidade do Alto Rio Grande* and *Companhia de Electricidade do Alto Rio Doce* will operate the Itutinga and Tronqueiras projects which will eventually be interconnected in a regional power system. *Westinghouse Electric International Company* is supplying the power generating apparatus. The first Itutinga generator is scheduled for shipment in the spring of 1954, and the second a year later. Shipments on the Tronqueiras project are expected to be completed by the fall of 1953.

CHILE—A special subcommittee has been appointed by the Legislative and Judicial Committee of the Chamber of Deputies to make a study of the proposal to nationalize all areas containing deposits of radioactive minerals.

MEXICO—*Banco de Comercio, S.A.*, surveying the industry, reported that mining production, particularly that of gold, copper, and lead, had dropped sharply because of high production costs, transportation, and an irregular market. The review covered the first quarter of 1952 and noted an improvement during that period for zinc and silver, although silver was still substantially low compared with production in the years immediately following World War II. During the first quarter of 1952, gold output averaged 31,524 ounces per month, compared with 32,181 ounces in 1951; and lead averaged 18,529 tons, compared with 21,798 tons. Copper averaged 3,244 tons in the first quarter but 5,361 tons in 1951.

BOLIVIA—The Council of Ministers at La Paz is reported to be considering construction of a tin smelter there. Construction of roasting and leaching plants is said to have been discussed with the United States Reconstruction Finance Corporation in the past, and bids are reported to have been received from Uruguayan, Argentine, and European contractors. The Bolivian government is said to be studying these bids but they do not extend to the construction of a tin smelter.



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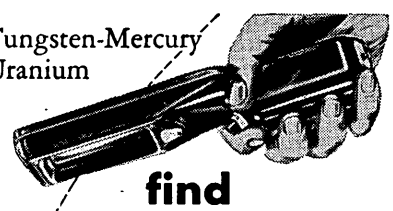

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INDIA—*Chowgule & Company, Ltd.* expects to begin shipments from its newly mechanized iron ore mines at Goa early in 1953. Most of the machinery from Japan has arrived and is being installed. Recently an agreement was concluded with a Japanese firm, with a view toward mechanizing the mines and obtaining an annual production of 500,000 tons of high-grade iron ore to be shipped to Japan. The eventual target will be 1,000,000 tons within a period of two years.

TURKEY—The *Karabuk Iron and Steel Works* is now said to be in a position to supply more than half of Turkey's annual requirements for iron and steel. The plant is now capable of producing annually 293,000 tons of coke, 115,000 tons of pig iron, 103,000 tons of steel, 72,000 tons of various iron products, 11,000 tons of cast iron pipes, 2,762 tons of ammonium sulphate, 16,000 tons of tar and pitch, 4,000 tons of benzol, and 345 tons of napthaline.

KOREA—Among the industrial targets bombed by United Nations warplanes in North Korea recently was a mining and ore processing plant at Sinhung, 60 miles south of the Manchurian border on the Yalu River. Damage was reported as 35 buildings destroyed and 33 damaged in the big plant.

INDIA—The price of quicksilver has risen sharply since the rumor that the Indian government might shortly permit the re-export of the metal. Large quantities were bought at the outbreak of the Korean War at prices ranging from £23 to £28 per flask. India's annual requirements are around 5,000 flasks, and the country is reported to have about 23,000 flasks on hand. Should re-export be permitted, traders believe the local price might reach 450 rupees, but this would still be well below the present U.S. price of $187 per flask, or the United Kingdow price of £64 per flask.

JAPAN—The government reportedly will permit *Aluminum Ltd.* of Canada to buy into the *Japan Light Metals Company,* subject to adjustment on minor points. The project has been held up for several months because of the fear that Canadian interests might control the Japanese aluminum company. The Canadian firm is said to have proposed to invest 744,000,000 yen ($2,060,000) to acquire 12,400,000 shares of stock at 60 yen per share. The company also was reportedly willing to loan 645,000,000 yen at 5.5 percent interest a year for eight years, and to supply technical help and shipments of bauxite.

TURKEY—Prospecting for chrome deposits is becoming increasingly extensive in certain areas of Turkey. The Turkish Trade Minister reports that the number of mining applications received rose from 4,280 in 1950 to 6,790 in 1951, and to more than 8,290 during the first six months of 1952.

THAILAND—The Ministry of Finance has announced that as of September 15, only 20 percent of foreign exchange derived from tin ore exports must be surrendered to the government at the official exchange rate. Previously, 40 percent had to be surrendered.

ISRAEL—A rich iron ore deposit has reportedly been found in the vicinity of Negev.

JAPAN—Five leading steel manufacturers—the *Yawatam, Fujim, Kawasaki, Nichia,* and *Yodogawa* companies—reportedly plan to buy $20,000,000 worth of steelmaking equipment from the United States. Authorization for the purchases is said to have been received from the U.S. and the action presumably will help cut the production costs of Japanese steel.

INDIA—India's best customer for mica, the United States, is cutting its imports of mica heavily. The result reportedly has caused near panic in the mica trade in Rajasthan and Bihar. United States imports decreased from 261,427 cwt. in 1950-51, to 177,099 cwt. in 1951-52. A progressive decline in the demand for mica splittings—seven-tenths of the mica trade—has caused many small

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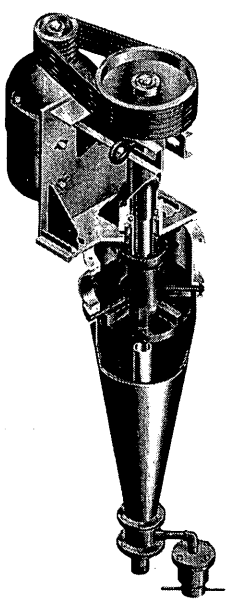

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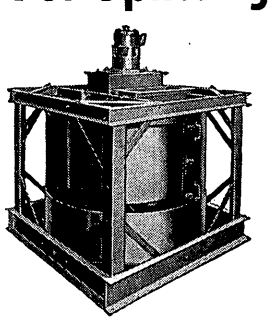

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factories to close down and the larger ones to reduce output. The trades and mining associations have drawn the government's attention to the situation and have recommended that the industry look for new markets and stop the export of mica scrap which is reducing the demand for virgin mica.

TURKEY—Rich workable veins with a tungsten content of about two percent are reported to have been shown in preliminary prospecting work on a deposit near Broussa. A group has been formed to supply the necessary equipment for developing the deposit next spring.

INDIA—With the help of *Messrs. Pilkington Brothers, Ltd.*, a company has been formed to work the Assam sillimanite deposits. Despite the intense difficulties caused by the nature of the jungle and the heavy rainfall which impede production and transportation, the company has established a group of industries near Nongmaweit in the Khasi Hills. Here, they quarry the sillimanite boulders; part-saw the large ones for final sawing elsewhere; and crush the smaller ones for resale to refractory manufacturers. A 22-mile road has been built to connect the quarry with a local road to Hahim, and a substantial fleet of motor vehicles has been provided. Electric power generators, water supply, and repair workships have been installed at the quarry, while in Calcutta precision machines have been installed to cut the partly-sawed boulders into furnace blocks. This is the first time that a substantial industry is now functioning from these deposits. Full-scale extraction of sillimanite at the mine began in October and November 1951. Production to March 1952 was 4,174 tons. The present goal is 5,000 tons per annum.

MALAYA—*Ampat Tin Dredging Ltd.* is reported to be financing from its own funds the transfer of Tujoh dredge to the new area on the Kent estate. It is hoped that the erection of the dredge will be finished by the end of this year, although there will be a further period of three months before the dredge reaches the production stage.

JAPAN—A new method of reducing the iron, nickel, and copper contained in sinter which remains after recovering sulphur from pyrrhotite has been perfected by Professor Nishihara of Kyoto University and the metallurgists of the *Fujikoshi Mining Company*. It will be applied on a commercial scale for the treatment of pyrrhotite from the company's *Okura* mine in Niigata prefecture. The pyrrhotite is roasted, and the sulphur dioxide gas is used to make sulphuric acid. The sinter is given a chloridizing roast in a rotary kiln. The water soluble nickel and copper chlorides are leached from the high-grade iron oxide, and, by electrolysis, nickel and copper are recovered. A new roasting furnace will have a capacity for treating 50 tons of ore; the reduction equipment will produce 40 tons of iron oxide, 500 kilograms of copper, and 300 kilograms of nickel from the sinter. The Suruga plant will be located in Fukui prefecture.

THE MARKET PLACE

MOTORS—M. G. SETS—TRANSFORMERS

ENGINEERED AND REBUILT BY SPECIALISTS IN OUR MODERN PLANT

MOTOR GENERATOR SETS

QU.	KW	MAKE	RPM	VOLTS DC	VOLTS AC
1 (3-U)	2400	Whse.	720	600	2400/4800
3	1000	Whse.	514	600	11000/6600
4	1000	G.E.	514	600	11000/6600
1	1000	G.E.	514	600	2300
1	500	C.W.	720	275	2300/440
1 (3-U)	500	Whse.	1200	250	440
2	500	C.W.	720	575	2300/440
2	250	Whse.	1200	125/250	2300
1	200	Ridgway	900	275	2300
1	155	G.E.	720	250	2300/440
2	150	Whse.	1200	250	2300
1	100	Al.Ch.	1200	125/250	4000/2300
1	100	Delco	1200	125/250	440/220
1	100	Ridgway	1200	275	4000/2300
1	100	C.W.	1200	125	440/220
1	85	C.W.	1200	250	440/220
1	75	Al.Ch.	900	250	2300
1	75	Whse.	900	75	2300
1	50	Burke	1750	250	440/220
1	25	Ideal	1750	125	220
1	25	Al.Ch.	1200	250	440/220
1	20	Al.Ch.	1200	250	440/220
3	15	Al.Ch.	1200	250	440/220

We can furnish any of these sets with exciters and VARIABLE VOLTAGE CONTROL engineered and rebuilt to your requirements.

Motor Generators of modern design, complete with control—still on their original foundations—available for immediate shipment.

(3)—G.E. 1500-KW, 250-VDC, 514 R.P.M., cpd., interpole, pole face windings, 2100-HP syn. motors, .8-PF, 13,200-V, 3-p, 60-cy. will reconnect to 6600 V. or 4160-V.

SLIP RING MOTORS—CONSTANT DUTY
3-Phase—60 Cycle

QU.	HP	MAKE	TYPE	VOLTS	R.P.M.
1**	1800	G.E.	MT-498	2300	357
1**	1200	G.E.	MT-26	2200	277
2**	1000	Al.Ch.	ANY	2200	235
1	800	G.E.	MT	2200	440
1**	600	G.E.	MT-20	2200	360
2	500	G.E.	1-16-M	2300	450
1**	400	Al.Ch.	ANY	2200	514
2	400	G.E.	MT-412	2200	450
1	250	Whse.	CW-937	440	1200
1	250	Al.Ch.	ANY	440	720
1	250	G.E.	MT-414	2200	300
1	200	G.E.	1-16-M	2200	600
1	150	G.E.	1-13-M	2200	1750
1	125	Whse.	CW-870	2200	900
1	100	Whse.	CW-766	440	1200
1	100	F.M.	H-20-C	440	900
2	100	G.E.	1-15-M	2300	514
1	75	Whse.	CW-7540	440	720
1	60	Whse.	CW	440	900
1	50	G.E.	MT-536	2200	1200
2	50	Al.Ch.	ARY	440	900
1	50	F.M.	SR	440	600
1	40	Al.Ch.	ARY	440	900

From our stock we can furnish manual and magnetic primary and secondary controls up to 3500-HP.

SYNCHRONOUS MOTORS
3-Phase—60 Cycle

QU.	HP	MAKE	P.F.	VOLTS	R.P.M.
1	6000	G.E.	100	2300	90
1	4350	C-W	100	13,200/6000	514
1	3000	Whse.	80	4800/2400	720
2	2100	G.E.	100	2300	360
2	1750	G.E.	100	2300	3600
1	1000	El. Mchy.	100	440	1200
1	750	G.E.	80	2300	450
1	700	G.E.	80	2300	720
1	250	G.E.	100	2300	514
1	250	El. Mchy.	80	440	400
2	200	Whse.	80	440	1200
1	190	G.E.	80	440	720
1	150	G.E.	100	2200	900
1	150	G.E.	100	550	600
1	150	G.E.	80	550	450
3	135	G.E.	80	4000/2200	1200
3	125	El. Mchy.	100	4800/2400	900
1	125	G.E.	80	2200	900
2	100	Whse.	80	440	1800
1	100	Ideal	80	440	900
2	100	G.E.	80	440	600
1	60	G.E.	80	440	1200
2	50	G.E.	80	440	600

With these we can supply—manual, semi or full magnetic, full or reduced voltage control.

METAL CLAD SWITCHGEAR

(2)—G.E. draw-out O.C.B.'s—600 amps., 15,000-V., type FKR-255-B, 250,000-KV interrupting capacity.

(1)—G.E. draw-out O.C.B. 600 amps., 15,000-V, type FK-46, 100,000-KV, interrupting capacity.

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FUMEALL a combination of virgin wool and Dynel, combines the undisputedly superior filtering qualities of wool with the strength, heat, acid, alkali and moisture-resistance of synthetic fibers.

FUMEALL is available in the exact porosity and weave which meet your specific requirements.... **FUMEALL** can be ordered as yardage or can be fabricated into bags of any size and specification.

Please write for additional details and samples of FUMEALL filter fabric for fume, dust or liquid filtration.

INDUSTRIAL FABRICS DIVISION

Portland Woolen Mills, Inc.

P.O. Box 2620 • Portland 3, Oregon, U.S.A.

ROCK RATES

FOR ROCK BOTTOM COSTS

P&H MAGNETORQUE*

puts an end to the old swing frictions

We'll make this promise: You'll never have to "baby" this machine, even in the heaviest going! It's *built* for it — all-welded of alloy steels throughout, the toughest construction known. *It means steady digging.*

But the big pay-off in extra production comes with Magnetorque electric swing — enough faster to deliver 5 cycles to 4 on other machines in the 2½ yd. class. And the "time-outs" for adjustment and replacement of swing friction linings can now be salvaged for increased yardage. Magnetorque lasts the life of the machine.

*T.M. of Harnischfeger Corporation for electro-magnetic type clutch.

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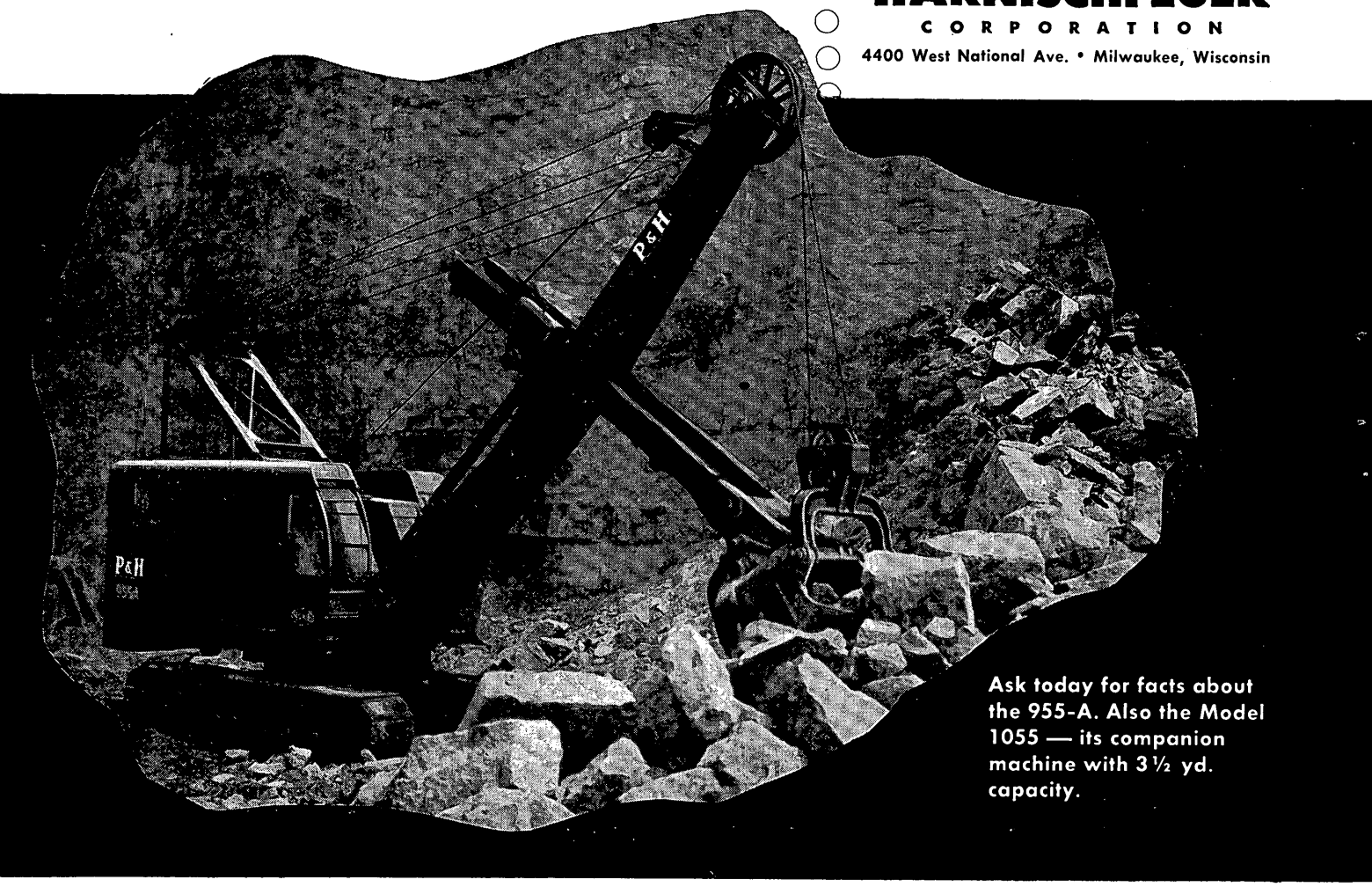
4400 West National Ave. • Milwaukee, Wisconsin



Ask today for facts about the 955-A. Also the Model 1055 — its companion machine with 3½ yd. capacity.

POWER SHOVELS • CRAWLER AND TRUCK CRANES • OVERHEAD CRANES • HOISTS • ARC WELDERS AND ELECTRODES • SOIL STABILIZERS • DIESEL ENGINES • PRE-FABRICATED HOMES

U.S. METAL & MINERAL MARKETS

METALS

OCTOBER 17, 1952

COPPER:	Electrolytic. Delivered F.o.b. cars, destination U.S.A.	24.50¢
	Lake. Delivered, destinations U.S.A.	24.625¢-27.50¢
	Foreign Copper. New York	36.00-36.50¢
LEAD:	Common Grade. New York	14.00¢
	Tri-State Concentrates, jig, flotation 80% lead, per ton	$176.00
ZINC:	Prime Western. East St. Louis	13.50¢
	Tri-State Concentrate, 60% zinc, per ton	$92.50
ALUMINUM:	Primary 30 pound Ingots (99% plus). F.o.b. shipping points	20.00¢
ANTIMONY:	Lone Star Brand. F.o.b. Laredo, in bulk	39.50¢
BISMUTH:	(In ton lots) price per pound	$2.25
CADMIUM:	Sticks and bars. 1 to 5 ton lots (Price per pound)	$2.00
COBALT:	97-99%, keg of 550 pounds (Price per pound)	$2.40
MAGNESIUM:	Ingots (99.8%). F.o.b. Freeport, Texas	24.50¢
MERCURY:	Flasks. Large lots, New York	$187.00-$193.00
NICKEL:	"F" Ingots (5 pounds). F.o.b. refinery, Port Colburne, Ontario	56.50¢
TIN:	Grade A Brands. New York (Price per pound)	121.50¢
TITANIUM:	99.3% + (Price per pound)	$5.00-7.00
GOLD:	United States Treasury price	$35.00 per ounce
SILVER:	Newly mined domestic. United States Treasury price	90½¢ per ounce
	Foreign. Handy & Harman	83.25¢ per ounce
PLATINUM:		$93.00 per ounce

ORES AND CONCENTRATES

BERYLLIUM ORE: 10 to 12% BeO. F.o.b. mine, Colorado ..... $36.00 per unit
Small lot purchases at Custer, S. D., Spruce Pine, N. C., and Franklin, N. H. Visual inspection at $400.00 per short ton or by assaying at: 8.0 to 8.9% BeO, $40 per unit; 9.0 to 9.9%, $45; and 10.0% and over, $50.

CHROME ORE: F.o.b. railroad cars eastern seaports. Long tons dry weight.
African (Rhodesian). 48% Cr_2O_3 ..... $45.00-$48.00
African (Transvaal). 48% Cr_2O_3. ..... $34.00-$35.00
Turkish. 48% Cr_2O_3. 3 to 1 chrome-iron ratio ..... $53.00-$54.00
U. S. Government ore purchase depot Grants Pass, Oregon, Base price, lumpy ore, $115.00; fines and concentrates $110.00 for 48% Cr_2O_3 and a 3 to 1 chromium-iron ratio. Premiums for higher grade ore and for a ratio up to 3.5 to 1. Penalties for grades down to 42% Cr_2O_3.

IRON ORE: Lake Superior. Per gross ton Lower Lake Ports.
Mesabi, Non Bessemer, 51.5% Fe ..... $ 9.05
Mesabi, Bessemer, 51.5% Fe ..... $ 9.20
Old Range, Non Bessemer ..... $ 9.30
Old Range, Bessemer ..... $ 9.45

MANGANESE ORE: Metallurgical grade. 46 to 48% Mn. Long ton unit ... $1.15-$1.23
Chemical grade. 80% MnO_2. Per ton $70.00
Chemical grade, domestic, 70% MnO_2, F.o.b. mines $45.00
U. S. Government ore purchasing depots: Deming, New Mexico; base price $2.30 per long dry ton unit of recoverable manganese less handling and treatment costs. Wenden, Arizona; base price of $8.54 per long dry ton of 15% manganese ore. Butte, Montana; base price of $6.05 per long dry ton of 12% manganese ore. Phillipsburg, Montana; base price of $6.43 per long dry ton unit of 15% manganese ore. Small lot program f.o.b. railroad cars, minimum 40% Mn. Base price (48%) $2.30 per unit with premiums and penalties.

MOLYBDENUM CONCENTRATE: 90% MoS_2. F.o.b. Climax, Colorado. Per pound of contained molybdenum, plus cost of containers $1.00

TUNGSTEN CONCENTRATE: 60% WO_3. Per short ton unit $65.00

URANIUM ORE: Carnotite-Roscoelite. F.o.b. purchase depot plus $0.06 per ton mile ($6.00 maximum), Grand Junction, Rifle, Durango, Naturita, and Uravan, Colorado. Salt Lake City, Marysvale, Thompsons, and Monticello, Utah. Shiprock, New Mexico. Base price for 0.10% ore is $1.50 per pound and up to $3.50 per pound of contained U_3O_8 plus $0.75 per pound for each pound in excess of 4 pounds per short dry ton and an extra allowance of $0.25 per pound for each in excess of 10 pounds. A $0.50 per pound development allowance paid on all ores purchases. At shiprock all ores with more than 6% lime are penalized for excess lime.

VANADIUM ORE: Carnotite-Roscoelite. V_2O_5 in ratio of more than 10 parts to 1 part of U_3O_8 are generally acceptable at all AEC depots, but excess not paid for at Marysvale, Monticello and Shiprock. . . . Per Pound V_2O_5, $0.31

NON-METALLIC MINERALS

BENTONITE: Minus-200-mesh. F.o.b. Wyoming points. Per ton in carload lots $12.50
Oil Well grade. Packed in 100 pound paper bags $14.00

FLUORSPAR: Metallurgical grade. 70% effective CaF_2 content per short ton F.o.b. Illinois-Kentucky mines ..... $42.00-$43.00
Acid grade. 97% CaF_2 ..... $60.00

PERLITE: Crude: F.o.b. mine per short ton ..... $3.00 to $5.00
Plaster grades. Crushed and sized. F.o.b. plants per short ton ..... $7.00 to $9.00
Concrete grades. Crushed and sized ..... $6.00 to $8.00

SULPHUR: Long ton, F.o.b. Gulf Coast mines $22.00

Quotations on metals and certain ores through the courtesy of *American Metal Market*, New York, N.Y.

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FLEXIPIPE®

...the quality ventilating tubing

DIRECTS FRESH AIR WHERE YOU NEED IT

The new improved Flexipipe is efficient, serviceable and economical. It's made in a variety of diameters and lengths and with various accessories to take care of your requirements. Write us for complete information and sample.

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PRODUCTION EQUIPMENT PREVIEW

PEP is just what new equipment, increased mechanization, and new methods can give to your mine, mill, or smelter. This PEP section is MINING WORLD'S way of making available to you some of the finest current information on mechanization.

Dart Truck Features Three Stage Torque Converter

This new extra-heavy-duty Dart truck is complete with Dart's heavy-duty, planetary-type rear axle, a 350-hp. Die-

sel engine, and a three-stage hydraulic torque converter with down-hill braking. Circle PEP No. 71 for complete load and performance specifications.

Thomas Flexible Coupling: No Lubrication, Backlash

The Thomas Flexible Coupling Company is announcing the distribution of its latest engineering catalog No. 51 describing its full line of all metal flexible couplings for power transmission.

This new catalog in a 9- by 11-inch leather binder provides much engineering data. Couplings are grouped and indexed to facilitate quick reference. Keyway data, standards for straight and tapered bores, as well as ordering instructions, are included for each group. Standard couplings are shown in individual sections of the catalog, and are followed by a special section showing many couplings designed for specific purposes with photos of typical installations.

A wide range of horsepower and speeds are covered, from small motor couplings to large industrial applications and main drives on Diesel locomotives and ships.

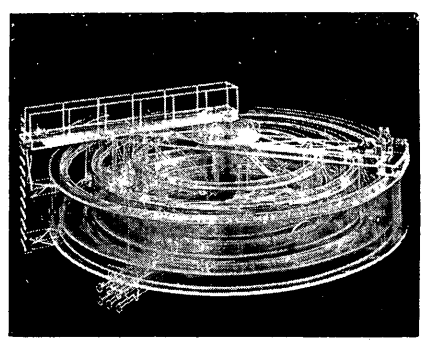
The Thomas principle embodies: no lubrication, no backlash, no maintenance, with adequate capacity for misalignment as well as free end float under load. All parts remain in balance, even under parallel and angular misalignments and all load conditions. There are no wearing parts in Thomas couplings.

If you have a power transmission problem, circle No. 83 for this free catalog.

NewConcen-TankThickener Designed For Many Uses

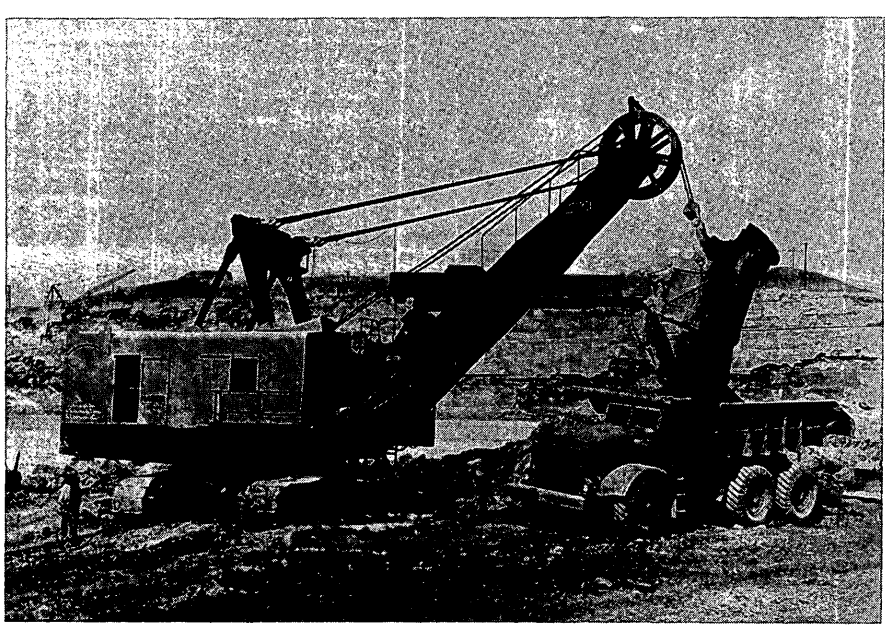
The new Morse Concen-Tank (Concentric Tank) thickeners offer many advantages over other conventional thickeners for metallurgical, chemical, cyanide, coal, and sewage disposal plants. They are especially desirable for series thickening and washing, countercurrent systems, and multiple-stage washing. They are flexible to meet a wide range of conditions and operating requirements.

Visibility is always clear and tank operation can be observed at all times. They do not require excessive headroom,



consume less floor space than a series of single thickeners having the same overall area. The eccentric tanks can be made of concrete, sidewalls of concrete with earthen bottoms, of steel, or any other suitable material. Only one operating mechanism saves power and usually not more than two traction arms are required.

Should any obstruction occur in any one of the tanks, it can be by-passed and removed without complete shut down of the Concen-Tank unit. For data on more thickening with less floor space at lower cost, circle PEP No. 72.

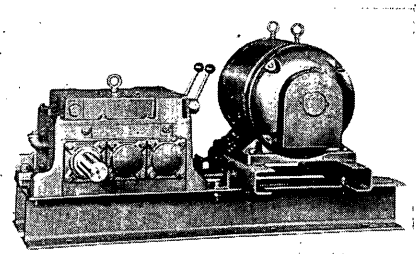


Marion's New 191-M Shovel

The Marion Power Shovel Company has just announced the newest power shovel, the 191-M, in its series of high-capacity, heavy-duty shovels. The 191-M was specially designed and engineered for open-pit iron and copper mines. Circle No. 70 for complete data about this fast-loading cycle shovel.

Variable Transmissions For Heavier Applications

The Turner Machinery Company, for over twenty years a manufacturer of power equipment, has announced three new models (2004, 3004, 5004) of multi-speed transmissions for use with prime movers rated up to 60 hp.

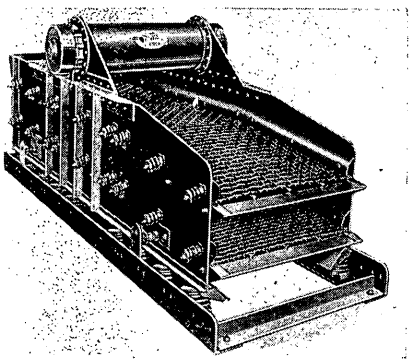


These units, available in from four to nine speeds, have resulted from over two years of engineering and test operation and are designed to control the output speeds of electric motors and internal combustion engines running at constant rates. For literature describing these units more completely, circle no. 76.

Lifetime Headmotion For Deister's Scalping Screen

Greatly increased sizing efficiency, as well as longer headmotion wear life, is now possible with the new UHS Deister heavy-duty scalping screen with new lifetime unitized headmotion, manufactured by the Deister Machine Company.

Built as a unit, the new lifetime headmotion features two-bearing construction, and runs in a bath of oil. Designed for extreme ruggedness, the new UHS scalping screen provides powerful but fully cushioned vibration, plus automatic screen cloth tension. The screen features Deister's opposed elliptical-throw action, which controls the movement of material on the screen for the greatest speed and efficiency of sizing. Advantages of the elliptical throw begin at the input end, where the material is thrown to the dis-



charge end to increase stratification—or "thinning"—of the load directly under the input chute. Near the center of the screen, the elliptical-throw becomes a circular throw, bouncing material up and down for stratification efficiency. Below the center, the elliptical-throw reverses to a holding action, thus retaining the thinned bed of coarser material on the screen long enough to permit maximum grading.

Circle No. 77 and find out why this new screen can do a better job for you.

New Belting Bulletin Gives Tips On Longer Belt Life

The Barber-Greene Company has just published an eight-page, two-color belting bulletin. Circle PEP No. 82 for your free copy.

Pictured and discussed are these major causes of belt failure—ply separation, carcass deterioration, irregular plies, edge wear, and longitudinal seam failure. The literature shows that the initial factors leading to early failure are defects of design or of construction. Advanced engineering, years of field experience and research plus precision manufacturing, have produced a belt which overcomes the major causes of early belt failure.

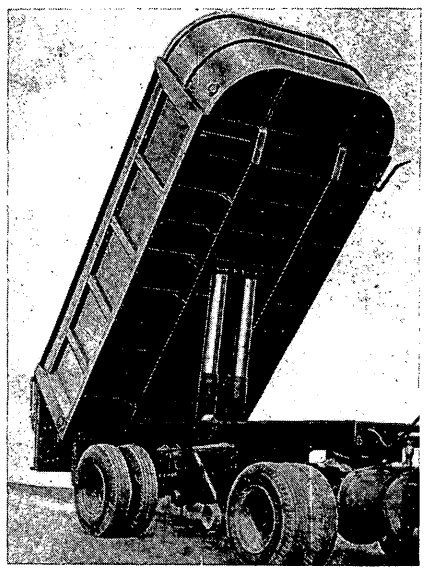
Unique belt selection tables are in two major sections simplifying a once complicated process. One two-page spread gives illustrations and specifications of the various belts. Use of the second two-page section is facilitated through the employment of a given example. Belt selection is accomplished by picking carcass and ply factors from an easily followed series of tables. These guides make it easy to choose the right belt for the job; belts for handling hot metal chips or stoker coal—for a permanent conveyor or a portable—for a new conveyor or a replacement.

Belts range from the light material handling belt to the heavy-duty belt for the most severe service. Included are the Hot Material belt and the Barprene belt which are made of specially compounded heat-resistant covers built to withstand the wear of extremely hot abrasive materials. The Barprene belt, made of neoprene, is especially designed to overcome the corrosive action of oil and grease.

Packaged Trailer Dump Bodies Now Available

The Galion Allsteel Body Company is now making a new series of single-axle, packaged, trailer dump bodies with capacities up to 20 cubic yards.

Known as Galion Model 12, the body is constructed of 10 gauge steel. It is 88 inches wide inside and has 32-inch sides and 44-inch ends. Standard equipment includes 12-inch steel removable side boards. Length can be varied up to 18 feet to provide any desired yardage capacity.



Dumping is handled by a Galion Model 77142 Hoist. This consists of two, 7-inch, twin ram single-stage telescopic cylinders. Rated hoist capacity is 18 tons.

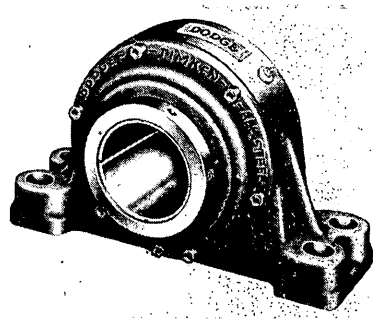
The trailer suspension is of heavy duty alloy main and auxiliary springs, one fixed and one adjustable radius rod, with flat top frame section. It is furnished with either a power fifth wheel or wet hose mounting. Tire sizes and brakes are available in several options to meet individual load and service requirements. Circle No. 75 for full information.

High Load-Carrying Dodge-Timken Roller Bearings

A new line of all-steel pillow bearings, providing high load-carrying capacity in a compact and rugged package, has just been announced by the Dodge Manufacturing Corporation.

These new bearings are a joint achievement by Dodge and the Timken Roller Bearing Company. High radial and thrust capacities, along with the stamina to take heavy-shock loads, have been provided within minimum dimensions and with far less than usual weight.

The bearings are fully self-aligning, with spherical outer race. They are available in both expansion and non-expansion types and have the adapter mounting which has proven so successful through the years. Double piston ring seals keep the lubricant in and dirt and dust out of the bearing mechanism. The bearings are sealed both on and off the shaft. They will be available in shaft sizes from 2 15/16 to 10 inches. Circle No. 73 for complete facts on this new bearing unit.



Tractor Maintenance Told in Cartoons

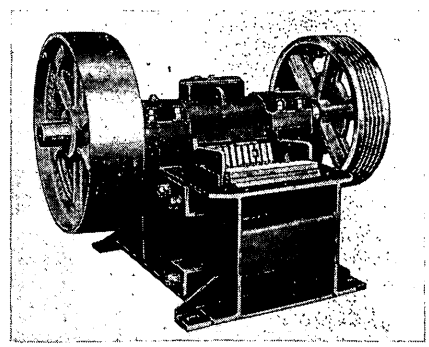
Another cartoon booklet devoted to equipment maintenance is now being offered by the Caterpillar Tractor Company. This booklet, "Maintenance Guide for Tracktype Tractors" tells in colored cartoons what happens when an owner and service technician compare job notes. The two men discuss basic methods of making tractors last longer and do better work at lower cost.

Operating adjustments are simply explained and proper care of tractor components, such as tracks, seals, fuel system and filters, is shown. Also featured is the opportunity to economize by having a dealer rebuild worn parts.

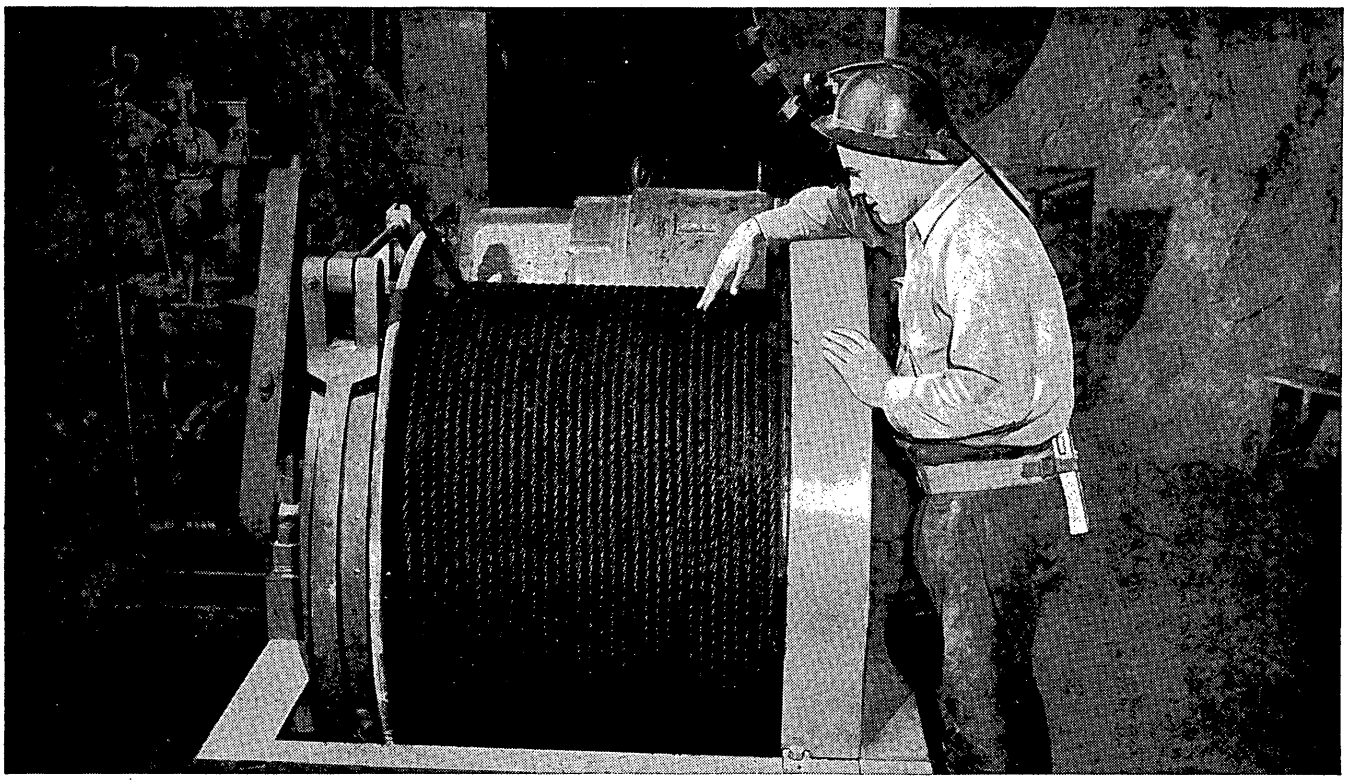
For your copy of the latest in this cartoon series, circle No. 78.

Light-Weight Jaw Crusher For High Tonnage Output

A revolutionary light weight 10 by 16-inch plain bearing jaw crusher is now available from Pioneer Engineering Works.

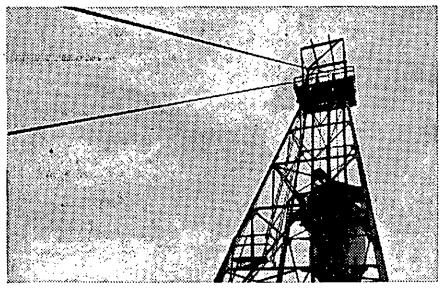


The new crusher features a single wall pressed steel base that is strong and rigid, and yet lighter in weight. The pitman bearing is a full round bronze sleeve bearing. Side bearings are bronze on the bottom half and babbitt on the top half. Bearings are protected by felt oil seals in each end of each bearing. Reversible jaw plates are of manganese steel. Production capacity will range from 4 to 40 tons per hour, depending on stage of reduction required. The approximate weight of the new crusher is 3,350 pounds. Circle No. 74 for your free copy of performance data for this new 1016 jaw crusher.



Lines last 6 times longer on this winze hoist in the Seeley Mudd Family's Coronado Copper & Zinc Mine, east of Tucson, since Supt. B. B. Gibbens made changes based on a Tiger Brand Specialist's wear study. Ropes now last 18 months instead of three.

Coronado Mine makes big savings with Tiger Brand Rope!



220 tons of ore daily are brought up from the Coronado Mine's Moore Shaft by these Tiger Brand wire ropes, yet they show only slight wear after almost two years of steady hoisting. One reason the ropes have held up so well is that a Field Specialist made sure in advance that they were right for the job they had to do.

"We've saved lots of money with the help of our Tiger Brand Specialist's advice on wire rope," says Mine Mgr. Fred E. Gray, above left, with Field Specialist J. J. Normart of Tucson. "By recommending the right rope for each job, Mr. Normart has helped us get longer, safer service from our Tiger Brand hoisting lines."

USS AMERICAN TIGER BRAND WIRE ROPE UNITED STATES STEEL

For any mining job you handle, rely on tough American Tiger Brand, the wire rope that's rigidly controlled by United States Steel from raw ore to finished product. To get all the stamina engineered into it, you're welcome to the services of a Field Specialist. Contact your local distributor or write Columbia-Geneva Steel Division, Room 1422, Russ Building, San Francisco 6.

USS

U·S·S TIGER BRAND Wire Rope

Columbia-Geneva Steel Division, United States Steel Company, San Francisco

UNITED STATES STEEL

Entrenched Bureaucracy

When the article entitled "Resources for Freedom" appeared in the August issue of *Mining World,* we read it with interest. A first thought was that an analysis of the article would be in order, but a second reading brought the decision that such a review was impossible within the limits of this column. There are, however, certain observations which we wish to make.

The Materials Policy Commission is composed of five members. The chairman is a radio executive. The second member was graduated from a school of mines 30 years ago, but he reformed and went to another industry. The third member was a graduate in electrical engineering, but became a mining executive, with a strong international flavor. The fourth member is an expert in public administration, and the fifth member is the editor of a high-class slick-paper magazine. They are all very busy men, and it is self-evident that they did not personally write all of the 1,000,000 words in the five large volumes of the Commission report. Like the members of all such government commissions, they become the captives of their staff. We intend to examine that report in detail.

In forming the staffs for these commissions, as a result of insistence by the members, the secretary may be chosen from civilian life, but, more often, as a result of official hints, he is chosen from one of the departments. The secretarial staff will be supplied by the placement officer of Civil Service. They thus may all be members of the official oligarcy.

In all the history of the world there never has been such a successful mineral development as this country has had under our prospector and location system of free enterprise. It is the envy of every other nation. Thus far it has met the test of every national emergency. In spite of this success, the last few years have seen a regular plague of suggestions for changes in the mining code, mostly originating in government bureaus. It, therefore, comes as a great surprise to find that this commission has not only listened complacently to these new suggestions, but that they are now recommending the adoption of every one of these mining innovations, which the mining industry, both individual and corporate, has so bitterly fought during the last few years.

If the commission's suggestions are adopted we can say "goodbye" to prospectors and their angel grubstakers.

Why adopt a leasing system when it has proved such a dismal failure as applied to Indian lands?

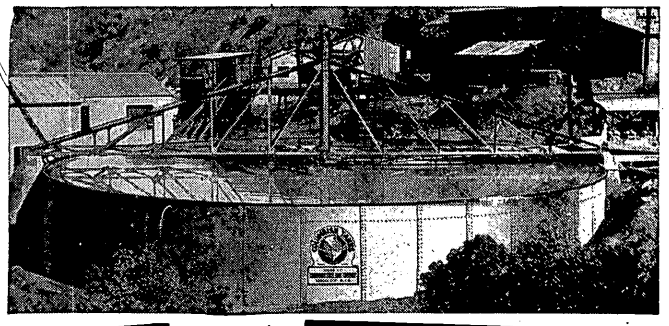
The system of apex and extralateral rights was developed as a matter of necessity. Without them there could not have been the Cripple Creek and Leadville developments, and the population of Boot Hill would have been doubled.

"That permanent legislation entirely independent of the Reciprocal Trade Agreements Act be enacted authorizing unilateral elimination of import duty on any industrial material . . ." By the paragraph beginning as quoted, the commission would bypass Congress, and leave departments free to act as they please in such matters.

When did the departments resume the issuing of patents?

Our readers can readily finish the catalogue for themselves.

The Wanderer



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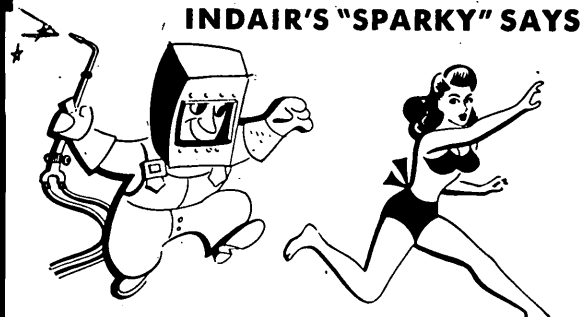

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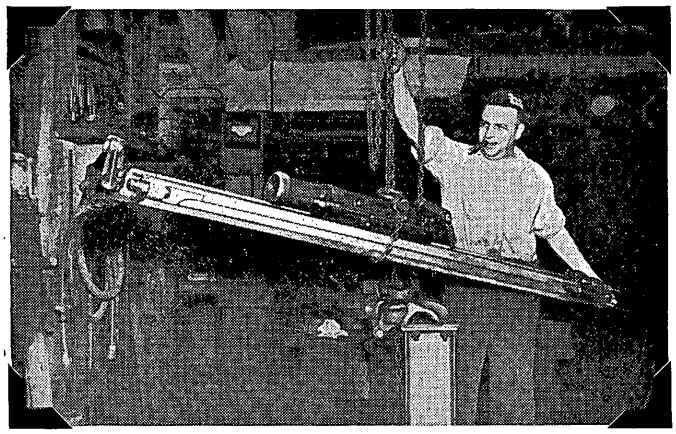
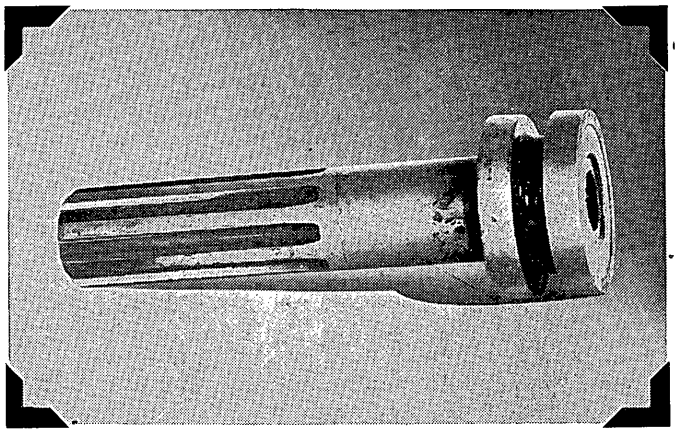
STANDARD ENGINEER'S REPORT

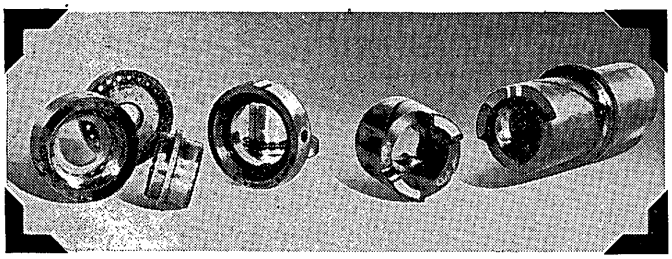
LUBRICANT: Calol Vistac Oil
UNIT: Rock drill-Ingersoll-Rand drifter
LUBRICATOR: Fine oiler
OPERATION: Deep underground mining
CONDITIONS: High humidity & temp.
FIRM: Sunshine Mining Co., Kellogg, Idaho

Only 0.001 wear on rock-drill piston in 120 shifts!





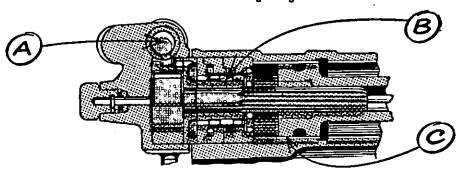
ON THE 3100-FOOT LEVEL of the famous Sunshine silver mine, this drifter, lubricated with Calol Vistac Oil, was in steady service for more than two months before coming in for service. When disassembled by "Drill Doctor" Dave Farnsworth, the piston "miked" only 0.001 inch wear despite the tough conditions in which the drill works. Working face is 400 feet below sea-level. Humidity is around 90 with atmosphere at a constant 75°F. After cleaning, the piston and other parts were put back in service.



VALVE-CHEST ASSEMBLY, chuck and chuck jaw from the drifter. Note the absence of lacquer or corrosion on air-valve parts. Because Calol Vistac Oil has held air-tool wear to the minimum and is approved by the miners, Sunshine Mining Co. has used it for more than 10 years.

REMARKS: Besides providing good air-tool lubrication without excessive vapor or bad odor, Calol Vistac Oil is excellent for heavy-duty plain bearings, reduction gears, motor gear heads, etc. It comes in several grades and may be applied by wick-, ring-, and drip-feed oilers.

How CALOL Vistac Oil cuts costs in air-tool equipment



A. Atomizes quickly and completely—carries, evenly over all parts. Does not fog excessively and has no unpleasant odor.

B. Additives help form tenacious, oily, pressure-resistant film in wet or dry conditions—cuts wear and power loss. Small quantity lubricates efficiently.

C. Resists high temperatures and oxidation. Stays fluid at low temperatures.

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STANDARD TECHNICAL SERVICE checked this product performance. For expert help on lubrication or fuel problems, call your Standard Fuel and Lubricant Engineer or Representative; or write Standard Oil Company of California, 225 Bush St., San Francisco.

STANDARD OIL COMPANY OF CALIFORNIA

precipitates—ROCKY MOUNTAIN

Resurrection Leases Famed Little Johnny Gold Mine

The Ibex Mining Company has granted a lease and option on its mining claims in the Leadville district of Lake County, Colorado, to the Resurrection Mining Company.

Included in the option was the famous Little Johnny mine, which is credited with a gold production valued at $60,000,000. The entire Ibex group developed through four deep vertical shafts has produced over $150,000,000 worth of ore, nearly all gold, but in recent years substantial tonnages of zinc-lead-silver-gold ore have been mined.

Initial Resurrection operations consisted of granting several leases on Ibex ground in areas accessible from the Yak Tunnel.

Resurrection is equally owned by the Newmont Mining Corporation, United States Smelting, Refining and Mining Company, and the Hecla Mining Company. Barney Greenlee of Leadville is Resurrection general superintendent.

Develop Copper-Uranium Mines in White Canyon

Cooper and Bronson's Happy Jack uranium-copper mine in White Canyon, San Juan County, Utah has developed a large tonnage of good-grade mill ore. Development is being continued under direction of the two partners.

In the same area, the Vanadium Corporation of America is continuing development at its Uracop copper-uranium claims. D. W. Viles, vice president in charge of mining, directs the corporation's White Canyon mine and mill.

A large number of prospectors and independent mining operators are doing development work on their claims with the intentions of shipping ore in the future to the Vanadium Corporation of America's White Canyon plant.

COLORADO

James P. Webb and Melvin Gaymon, operators of the *Pittsburgh* placer claim in Breckenridge, Colorado, have uncovered a five-foot vein of lead and zinc ore while doing some surface work. Present plans call for further development of the vein by stripping with a dragline, and, at the same time, sinking on the vein. The ore will be hand-sorted as it is stripped. The fines will be screened off and run through sluice boxes to recover the lead. Meanwhile, other veins in the area will be uncovered by bulldozer and stripped by dragline.

Development work started last spring is continuing at the *Bachelor* and *Syracuse* mines north of Ouray, Colorado, according to manager J. R. Sonza. Mine crews are driving a raise from the 300-foot level to prospect for mineralization found on the 200-foot level. Meanwhile, shipments of lead-silver ore are being made regularly to the nearby American No. 1 custom mill of the *American Zinc, Lead & Smelting Company*. The mines are the property of the *Bachelor Development Company*.

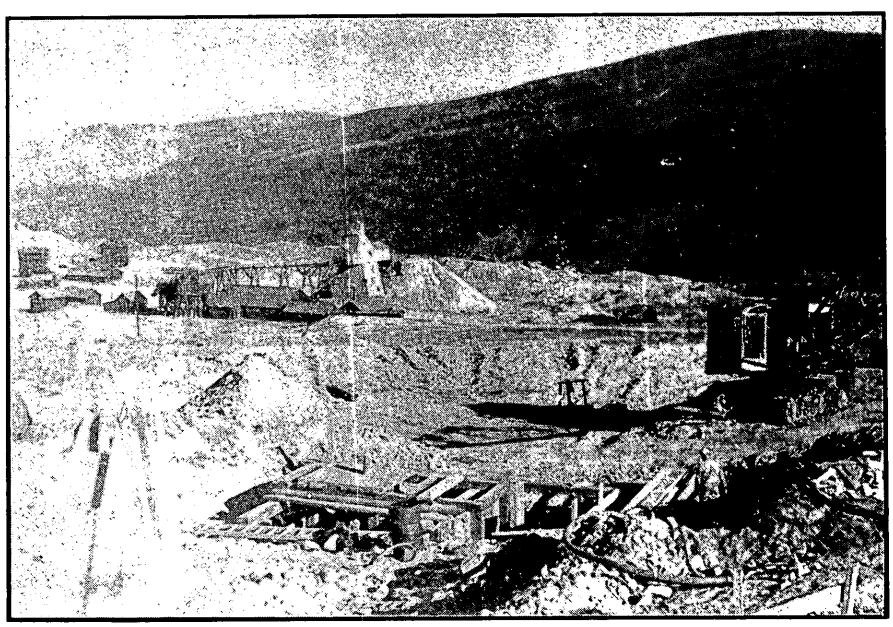
In the Leadville mining district of Colorado, the *Newmont Exploration Company* has five surface diamond drills and one underground diamond drill in operation. Three drills are being used in Iowa Gulch south of Leadville, and two are in use in Big Evans Gulch east of the city. According to reports, several holes have been drilled to a 1,000-foot depth. Newmont Exploration also completed an extensive diamond drilling project recently near the *Vulcan* mine, Gunnison, Colorado.

A low-level adit begun in 1949 was recently completed at the *Grizzly* mine of the *Lupton Mining Company*, located near Silver Plume, Colorado. The new lower adit, partially financed by a $65,000 participating loan from the Defense Materials Administration, is designed to eliminate a water drainage and hoisting problem at the Grizzly and to open a large body of lead and silver ore. According to Major Ellis P. Lupton, head of the company, by driving the adit and a 343-foot raise, several thousand tons of mill-grade ore have been blocked out on three sides. He also reports that his miners are driving a drift on the Grizzly vein and are in good ore. Output is processed at Lupton's Commonwealth flotation mill at Georgetown, which is operating on a three-shift-per-day basis.

The *Leadville Lead Corporation* is starting a diamond drill exploration program at its Dauntless tunnel in Park County, Colorado. Exploration, aided by a Defense Minerals Exploration Administration loan, has been in porphyry to date. The tunnel was reopened in 1949 as part of an overall expansion program.

The *Venture Leasing Company* has begun operating its new 50-ton-per-day differential lead-zinc flotation mill at the *Gold Prince* mine in San Juan County, Colorado. The mill, located at the lower tunnel of the Gold Prince, was built with the aid of a $23,000 Reconstruction Finance Corporation loan. John Cook, Leslie Larson and William Gianetto are partners in the company which built the mill last summer.

Earl Crowl, previously the largest stockholder in the *San Juan Gold King Mines, Inc.*, has reportedly purchased the



ASARCO DIGS DEEP LEADVILLE SHAFT

The American Smelting and Refining Company has started sinking its large new Irene shaft on the top of Johnny Hill in the Leadville district, Colorado. Pictured here is the collar of the three-compartment, 17 by 7-foot rock section shaft which will be sunk over 1,000 feet. The picture was taken looking northwest and plainly shows the Ibex No. 2 shaft in the background. A Riddell mucker will be used for sinking the shaft. It will connect with the Irene winze, which the company sank several years ago from the Eclipse shaft workings to develop the down-faulted Leadville Blue Limestone. On completion of the shaft it will be possible to mine the lead-zinc-silver-gold ore developed by the smelting company during the past several years. At present, development ore is hoisted from the Irene winze, trammed to the Eclipse shaft, and hoisted to the surface. J. Fred Johnson, western manager of mining operations for ASARCO, is supervising the Leadville operations.

entire property and plans to begin preliminary improvements before winter. First work will be done on the American tunnel, where known veins will be developed by drifting and drilling. The famous gold-producing Colorado property, which has been closed for 30 years, had a production record of over $8,250,000 during the years that it was operated.

Ozark-Mahoning Company, an Oklahoma firm, has to date invested approximately $1,000,000 in its fluorspar mining and milling operation in Colorado's North Park area. Newest development is the construction of a 250-ton-per-day flotation mill about five miles north of Cowdrey. Sixty-five men are employed at the mill, of which R. K. Wisco is general superintendent and M. P. Cloonan is plant superintendent.

U. S. Vanadium Company largest single producer of uranium in Colorado, has doubled the capacity of its mill at Uravan, Montrose County, Colorado. U. S. Vanadium operates a second uranium-vanadium mill at Rifle, Colorado, and recently completed a remodeling of its uranium-vanadium ore sampling plant at a cost of $48,000.

Climax Molybdenum Company, Climax, Colorado, recently acquired the world's largest primary gyratory crusher for use at the new Storke Level crushing plant. The 500-ton machine, built by the *Nordberg Manufacturing Company,* has a 60-inch feed opening and stands as high as a three-story building.

Shipments of ore reportedly will be forthcoming soon from the *Park View* uranium-vanadium mine in Mesa County, Colorado. A new road has been completed to the property, recently purchased by C. E. Wright of the *D. & N. Lead Mining Company.*

UTAH

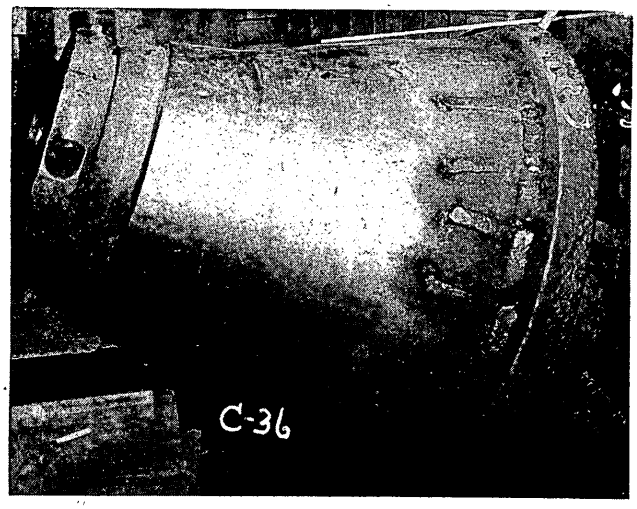
Quantity production of cobalt should begin "in the relatively near future" at *Howe Sound Company's* chemical refinery near Garfield, Utah, according to H. H. Sharp, Howe president. *Chemical Construction Company,* present operators of the plant, had expected an earlier opening, but at present repairs are being made on the stainless steel machinery and officials say they are still in the process of "tuning up." The plant has a capacity of more than 2,500,000 pounds of cobalt per year, and will make 90 percent of all cobalt produced in the United States when it is in full operation. It will also be the largest producer of the vital defense material in the Western hemisphere. Chemico and Howe Sound are collaborating on the first commercial application of a new reduction process, and will convert concentrates from Howe Sound's Idaho cobalt mine.

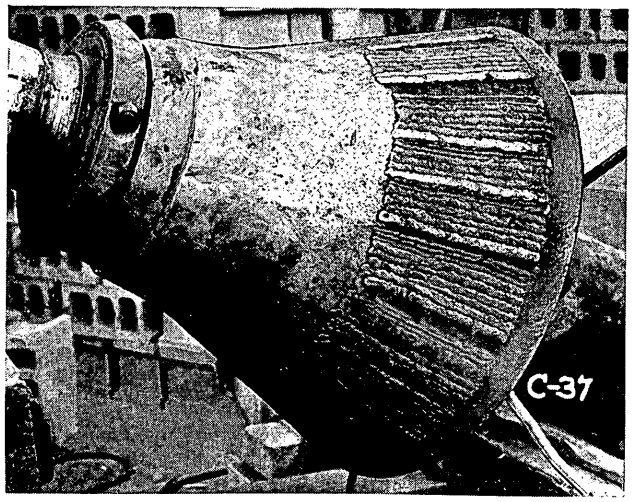
The shaft being sunk at the *Yellow Canaries* uranium claims of the *Howell Mining Company* is now down 250 feet. Located in the Marysvale district of Utah, its bottom is believed to be about 100 feet lower than any other working in the area. Some uranium ores were found during the process of sinking, but not in large enough amounts to be commercially feasible. The shaft sinking was started in September 1951, and three men have been working on it continuously since then.

SOUTH DAKOTA

Uranium work has progressed impressively in the Craven and Cole Canyon areas of South Dakota's Black Hills, according to Senator Karl Mundt. A new ore loading dock is nearing completion at Edgemont on a spur track of the Burlington Railroad, and the U. S. Atomic Energy Commission has asked for bids on core and non-core drilling. Prospecting chances are enhanced even further by the discovery of uranium in the Lakota sandstone.

Production increased during the second quarter of 1952 at the *Homestake* Mine, property of the nation's largest gold producer, the *Homestake Mining Company.* A state tax report showed that the mine produced 303,739 tons of ore and that the gold extracted was valued at $4,130,557.32. Silver in the ore was valued at $20,688.08. Production during the first quarter of 1952 was 244,536 tons, with a value of $3,559,401.51.





Before and After Applying N. M. MANGATONE and RESISTO-LOY

This rebuilding job on Gyratory Liners was accomplished economically despite the fact that well over an inch of deposited metal was required all around the bottom third. Note the very badly worn areas in the "before" picture. Then note the perfectly done, finished job.

This rebuilding was done by the plant maintenance welder, using our N.M. Mangatone to rebuild the liner and making the last pass over the lower 15 inches with Resisto-Loy. This final coating pays a fine dividend in additional wear resistance.

Why not put in a call for our field man. He can show you many ways to save materials and money.

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precipitates—NORTHWEST

Northwest Convention Set For December Meeting

The 58th annual convention of the Northwest Mining Association which will be held in Spokane, Washington, on December 5 and 6, will feature a technical session on mechanized mining in Washington's Metalline Falls district. This session will be held in the afternoon under the chairmanship of Dale I. Hayes, western manager of American Zinc, Lead and Smelting Company.

The opening session under the chairmanship of A. E. Weissenborn, Spokane geologist for the United States Geological Survey and the Defense Minerals Exploration Administration, will highlight mining developments in Washington, Idaho, and Montana.

The technical session on Saturday, the 6th, will be jointly sponsored by the Columbia section of the AIME with J. C. Kieffer, assistant manager American Smelting and Refining Company's Coeur d'Alene district, as program chairman.

Chester H. Steele, general manager of western mining operations of the Anaconda Copper Mining Company, Butte, Montana, will be the featured speaker at the Saturday noon luncheon.

Robert J. Towne, manager of Towne Equipment Company and Northwest Association trustee, is general chairman of the convention and has arranged a dinner dance for Friday night, the traditional sourdough breakfast for Saturday morning, and the annual banquet and dance for that evening.

Sullivan Building Idaho Sulphuric Acid Plant

A certificate of necessity has been granted the Sullivan Mining Company by the Defense Production Administration to construct a $5,352,370 sulphuric acid plant near Kellogg, Idaho. The company will be allowed to write off 70 percent of the cost over a five-year period.

Construction is now under way, and the plant is scheduled for completion by the end of 1953 or early in 1954. It will produce 250 to 300 tons of sulphuric acid daily. The acid will be obtained from gases given off in the zinc concentrate roasting process at the nearby electrolytic zinc plant. Engineering for the plant is by Singmaster and Breyer, New York, New York metallurgical and chemical engineering consultants. The Leonard Construction Company of Chicago designed the plant, and it is being built by Stearns-Rogers Construction Company of Denver.

Production at the electrolytic zinc plant has been curtailed 20 percent because of the recent power shortage in the Pacific Northwest. Interruptible power supply by the Washington Water Power Company was cut off when the Bonneville Power Dam Administration decided to drop such power until rains increased the water supply. This meant a loss of about 1,000 tons of high-grade zinc monthly, reports Superintendent Wallace G. Woolf. However, sufficient stocks of slab zinc are maintained by the company to offset this lower production for about three months.

Sullivan Mining Company is owned jointly by Hecla Mining Company and Bunker Hill & Sullivan Mining and Concentrating Company. The Bunker Hill smelter was not affected because the smelter's power supply is on a firm basis.

IDAHO

Mullin Mines Company, headed by James Collard of Golden, Idaho, has undertaken a $12,400 DMEA tungsten exploration project at the *Tungstar* group in the Ten Mile district of Idaho County. The government will put up $9,300 of the cost of surface trenching and bulldozing, and installation of slusher and washing plant equipment.

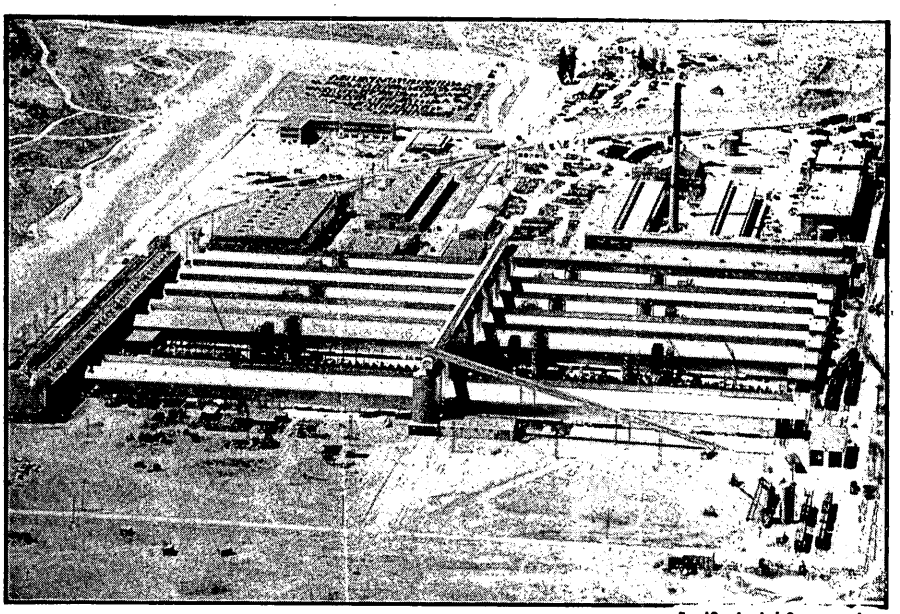
Lucky Friday Silver-Lead Mines has started westerly exploration of its vein system in the Hunter district of the Coeur d'Alenes, Shoshone County, Idaho, following leasing of 99 acres of adjoining *Gold Hunter* ground from *Day Mines, Inc.* The lease calls for a royalty of 14 percent of net smelter returns. Between 400 and 600 feet will be driven on the 2,000-foot level in Lucky Friday ground before reaching the Gold Hunter property. Drifting is underway on the same vein in which the Lucky Friday has opened up, on the east drift, a shoot of continuous ore over 700 feet in length.

Mascot Mines, Inc., has started development of a new No. 10 level at the *Little Pittsburg* mine in the Pine Creek district of the Coeur d'Alenes, Idaho. The No. 9 level, now being brought into production, is yielding millheads running between 7.5 and 9.0 percent lead-zinc, according to Claude E. Nugent, secretary-treasurer.

Lucky Six Mining Company of Juliaetta, Idaho has been incorporated by Donald Cantril, John Longeteigs and Alex McIntosh of Southwick, H. C. Freeman and Harold V. Freeman of Juliaetta, and Frank Cantril of Kendrick.

Silver Star-Queen Mines, Inc., has built a new compressor house, installed a 515-cubic-foot compressor, completed a new sawmill, and purchased a six-room house on adjacent ground to alleviate a housing shortage. Sixteen cars of ore have been shipped since production was started at the Blaine County, Idaho property last June. Nat T. Davis is president.

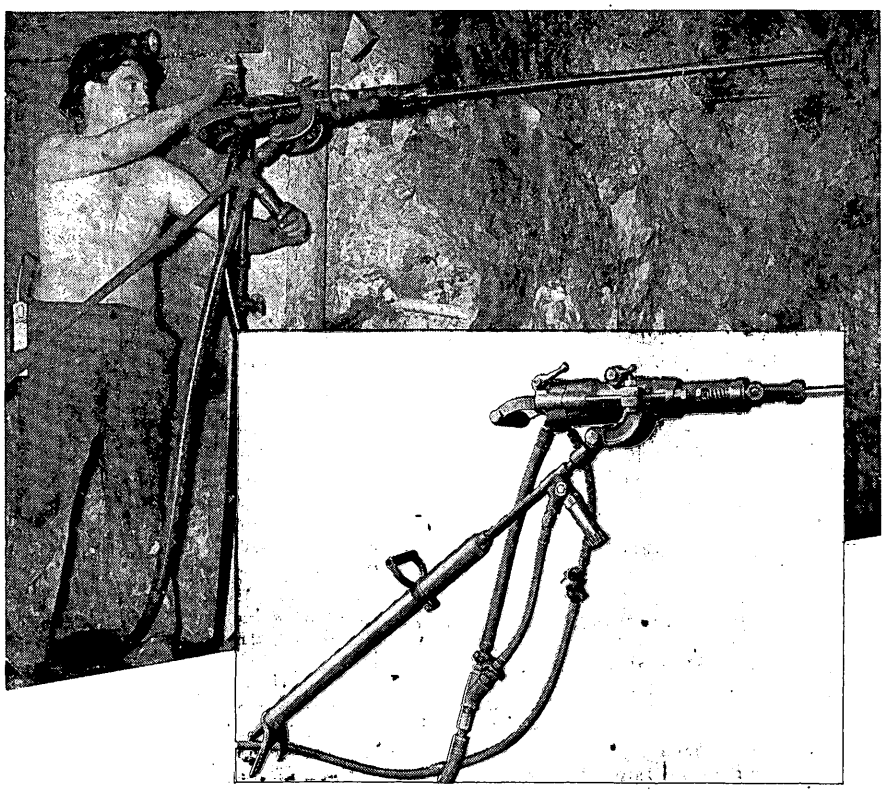
Polaris Mining Company of Wallace, Idaho which recently took over *Silver Summit Mining Company* in a merger,



Pacific Aerial Surveys, Inc.

ALCOA'S NEW $45,000,000 SMELTER

The Aluminum Company of America's new $45,000,000 smelter has been officially opened at Wenatchee, Washington. Although not completely finished, pouring of aluminum began late in June. Two of the four potlines have now been finished, and complete operation of the plant is expected early in 1953. Annual output will then be 170,000,000 pounds. The power needed to produce this amount of aluminum—170,000 kw—will be supplied by the Bonneville Power Administration and the Chelan PUD's new Rock Island Dam facility. When in full production, the plant will require 13 railroad cars of supplies daily, and will ship out 35 carloads of aluminum pig and ingot each week. W. N. Farquhar is works manager, and G. T. Holmes is aluminum plant superintendent.



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*Five out of six mine operators buy *COPCO rock drilling equipment when they see it demonstrated.*

When one man can outdrill two, it's no wonder so many operators are changing over. Every western mining town is buzzing with talk about this new Swedish rock drilling method.

The ***COPCO COMBINATION** is light in weight, but it's rugged and powerful. One miner can set up and drill out easier and faster than two men can use conventional equipment.

***COPCO ROCK DRILLING EQUIPMENT**

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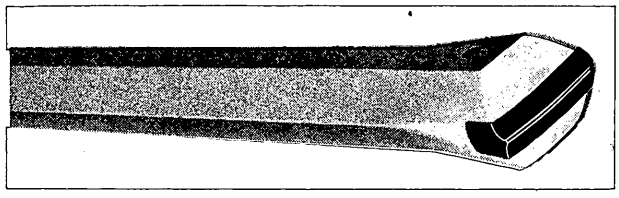

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has started exploring the main Silver Summit vein at the 3,000-foot level. This structure is about 950 feet south of the productive No. 3 vein. It will be followed westerly for 2,000 feet, company officials have announced.

Golconda Lead Mines, another Shoshone County, Idaho producer, has unwatered old shaft workings to below the 1,600-foot level. It is retimbering the station at that horizon preparatory to unwatering the bottom 1,800 level and carrying out extensive development work there. Some of the recent production has been from adjoining *Square Deal ground.*

Nabob Silver-Lead Company's concentrator in the Pine Creek district of Idaho now is treating ore from the recently opened Mascot vein in the *Nabob* mine. Several stopes have been started. Mill feed also has been coming from lessee operations in old upper workings on the Denver vein. Additional exploration of the Nabob vein is getting underway.

Gibbonsville Mining and Exploration Company expects to put its new 400-ton zinc-lead-silver flotation plant into operation about November 1, according to Earnest E. Eddy, manager. The mill was built with the aid of a $62,000 RFC production loan to treat an estimated 140,000 tons of mill tailings. These tailings were washed down the south fork of the Coeur d'Alene River years ago from the Wallace-Burke area and collected two miles west of Kellogg. The tailings are said to contain 2.27 percent zinr, 2.71 percent lead, and 2,07 ounces of silver to the ton. Walter C. Clark of Seattle was reelected president recently.

Kootenai Dike Mines, Inc., is planning to unwater and deepen a 100-foot shaft at its *Idamont* property near Leonia, Boundary County, Idaho, according to Dr. Ray E. Currie of Oakland, California, who is president. Ben Chamberlain of Moscow and Orofino, Idaho, has been named manager of mine operations.

Western Consolidated Mines, Inc. has made substantial progress in its rehabilitation and development of the *Ophir* mine in south central Idaho. The firm started development work in June 1950. Since then many of the old workings have been reopened and new exposures made on the vein body by tunnel and trenching. Ore samples reportedly carry gold and silver values. The original 285-foot, two-compartment vertical shaft has been reopened to the 205-foot level; a complete mine camp has been built; and a 100-ton flotation mill has been installed. The mine was closed down in 1890.

The *Polaris Mining Company* vein system, productive in upper levels but virtually barren in intermediate levels, is yielding rich silver ore at deep levels opened from the adjoining *Sunshine Mining Company* workings, officials have announced. Development work from Sunshion's 3,400-foot level disclosed a 200-foot oreshoot averaging 4.4 feet in width and 93.33 ounces of silver per ton. Additional length of mineralization has been opened on the same level, and on the 3,700 level (1,000 feet below sea level and a mile below the outcrop) the same vein is yielding "excellent" ore with indications that the shoots will extend a considerable distance below the level. The Polaris veins now are providing an important part of production shared equally by Polaris and Sunshine. In recent years, Polaris income has been largely from its share of the Omega and Rotbart areas of the Chester vein system, north of the Polaris system.

Montana Coal & Iron Company is driving a 600-foot tunnel to expose cobalt-copper veins at a depth of 200 feet below the surface at property in the Blackbird mining district of Lemhi County, Idaho. The work is being carried on under a $23,000 DMEA contract.

MONTANA

Amador Mining Company has given up an exploration project at the old *Amador* mine on Cedar Creek, south of Superior, Montana. Company officials said that extensive work carried on this year included unwatering of the shaft to the 700-foot level and clearing 7,000 feet of tunnel. The vein which had been worked by earlier operators was found to be still in place on the 700-foot level but was too low in grade to be mined at a profit, running from 0.07 percent to 3.41 percent copper. The recommendation to cease any further expenditures on the property was made by Irving G. Irving, representing the Galigher Company of Salt Lake City. The work was being done under a $72,190 DMA project.

United States Steel Company has taken an assignment of a 99-year lease held by S. A. Cummings, et al, on a fluorspar property southeast of Darby, Montana, and has started shipments of fluorspar to its Geneva Works in Utah. Owners of the 11-claim property are R. D. Flightner, Lester Thompson, and A. O. Cumley, all of Darby. They will receive royalties depending on fluorspar grading.

A good grade of lead ore has been found by diamond drilling beneath the present lowest level at the Superior, Montana, property of *Nancy Lee Mines, Inc.*, according to Robert H. Svendsen, company geologist and mining engineer. Deeper drilling is planned.

Caledonia Silver-Lead Mining Company of Kellogg, Idaho, has announced that it has optioned six gold mines in Montana's North Moccasin mining district, and plans to start immediate prospecting of the 1,000 acres involved. The mines, all early-day producers, are the *Kendall, Barnes-King, Santiago, North Moccasin, Mule Shoe* and *Horse Shoe.*

Lexington Silver-Lead Mines, Inc., has shipped a carload of concentrate from its mill at Niehart, Montana. The mill is treating dump ore taken from upper levels more than 50 years ago and discarded because it was not of direct shipping grade. The mine is being readied to resume production. J. A. Allen of Spokane is president.

A certificate of location for a placer mining claim on 120 acres in the Yellowstone County mining district of Montana has been filed with the county clerk at Billings. The claim is for the mining of bentonite and other minerals, and covers lot 10 and SW ¼ SE ¼, Section 30 T. 1 S., R. 26 E. and NW ¼ NE ¼, Section 31 T. 1 S., R. 26 E. A shaft five by 10 feet, and three feet deep, has been sunk in the center of Lot 10 Section 30, according to the location certificate. Signers include Lloyd Hatch, Clarence W. Avery, Fred W. Henderson, Sr., Grant F. Lampert, Richard D. Shay, and Oscar R. Burnside, each having one-sixth interest.

OREGON

Chrome concentrates assaying nearly 48 percent Cr_2O_3 have been shipped to the government purchasing depot at Grants Pass, Oregon by Bert Hayes of John Day, Oregon. He is mining chrome ore from the *Dry Camp* mine.

A 50-ton-per-day chrome concentrator is being built by Paul Littell and J. S. McKee in Grants Pass, Oregon. It will treat ore from the *Black Bird* mine near the mouth of Swede Creek, leased from Pete Neubert of Grants Pass. Littell and McKee, along with the *Idaho Canadian Dredging Company,* have built a mill on the *Eagle* property north of Bandon in Coos County to process black sand. The mill has 14 tables; magnetic separator will be added. Recoveries are expected in gold, platinum, chromite, magnetite, ilmenite, garnet, zircon, and monazite. George Murphy is in charge.

Ashland Mining Company is mining chromite by open-pit methods at the *Shady Cove* prospect near Galice in Josephine County, Oregon. Ore is trucked to the firm's mill near Ashland. The company also is stock-piling tungsten ore mined from the *Mattern* deposit near Ashland.

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Fred Gardner of Harbor, Oregon, has discovered chromite in the Vulcan Peak district of Curry County. The deposit consists of stringers up to four feet in width in sheared and serpentinized saxonite and dunite. A small tonnage has been mined.

Pacific Carbide & Alloys Company is producing agricultural limestone at its Portland, Oregon plant from limestone quarried near Enterprise, Wallowa County, Oregon.

WASHINGTON

Mines Management, Inc., of Spokane, Washington recently made initial shipments of concentrates from its 50-ton Advance mill near Northport in Stevens County, according to W. R. Green, president. A car of zinc concentrate went to the Sullivan Mining Company's electrolytic zinc plant near Kellogg, Idaho, and a car of lead concentrate to Cominco's smelter at Trail, British Columbia. Most of the ore milled was from development work in the firm's *Advance* mine six miles south of Northport. At the company's *Iroquois* mine, three miles northeast of Leadpoint, drifting is underway to check on a diamond drill core which showed a better than average grade of ore.

Mount Rainier Mining Company of Seattle, Washington, has obtained DMEA approval of a $3,000 copper-molybdenum exploration project in Glacier Basin in Mount Rainier National Park. The company, owning three patented lode claims, proposes to reopen two old tunnels on the *Snowflake* claim for examination and sampling.

Grandview Mines of Spokane, Washington is exploring five prospects in Stevens and Pend Oreille counties. Surface stripping has uncovered promising zinc showings one mile west of the *Anderson* open-pit zinc mine and diamond drilling is planned. On ground northeast of the Anderson, diamond drilling is being carried on following churn drilling through overburden. Surface bulldozing and diamond drilling also are underway at the *Plug* prospect, near the *Farmer* mine, and on Currant Creek. In Pend Oreille County, bulldozing has disclosed fair zinc mineralization at the firm's *Jim Creek* holdings southwest of the Metaline Falls district, home of the *Grandview* lead-zinc mine.

Dominion Lead Mining Company of Colville, Washington has mailed shareholders liquidation checks totaling $29,067 or 6½ cents a share after selling its *Old Dominion* silver mine to Earl B. Gibbs of Colville, and Ira B. Hunley of Spokane, for $35,000. Lee S. Wood is secretary-treasurer. The new owners have reopened old workings and are probing for new ore bodies.

Diamond drilling at the *Admiral* mine, near Leadpoint, Washington, has disclosed ore under the present lowest operating level, according to W. C. Hawes, secretary-treasurer. New ore also was found in a horizontal drill hole and an old crosscut will be extended to it. Milling of zinc-lead ore from old stopes has been resumed following mill improvements.

Northwest Magnesite Company has put into use a new steel tram discharge terminal at its Stevens County operations, in Washington, reports Howard R. Ziebell, general manager. The terminal is at the main Chewelah reduction plant at the end of a series of tramways which carry ore 13 miles from the Red Marble quarry. It was fabricated by *Riblet Tramway Company* of Spokane to replace an old wooden terminal.

The Washington state Division of Mines and Geology is making an economic study of mines in the Colville area of Stevens County. C. Phillips Purdy, Jr. division geologist, is in charge. Findings will be published along with a geologic map of the area next spring, according to Sheldon L. Glover, division supervisor.

Pend Oreille Mines and Metals Company is adding four duplex units to the 50 prefabricated houses it set up near Metaline Falls, Washington, last year for its workers.

Spokane and Kittitas, Washington men, headed by Ralph R. Weeks, Spokane attorney, have formed a partnership to mine a large oil shale deposit 10 miles east of Ellensberg. The Washington state highway department formerly took the material for road ballast and surfacing purposes.

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White Pine Copper Project Making Rapid Strides

The White Pine Copper Company, a subsidiary of the Copper Range Company, has received its first disbursement of $4,861,105, under the $57,185,000 loan authorized by the Reconstruction Finance Corporation to develop the new copper mine at the White Pine property in Ontonagan County, Michigan. When in full production by the end of 1954, 36,000 tons of copper is to be produced annually.

With some 800 construction workers swarming over the area, work on the project is proceeding rapidly. Headway is being made at the mine site, the town site, and in the residential section. Most of the 100 acres needed have been cleared and leveled. A good start has been made on the 14-mile railroad extension from Bergland, and on three workers' dormitories, a staff dormitory, service building, boiler house, water treatment plant, power station, mine buildings, and hospital.

The Upper Peninsula Power Company is building a 20-mile, 69,000-volt power line from its Victoria hydroelectric plant near Rockland to the mine. The line will supply power during the present construction and later will serve permanently for the White Pine townsite. The mine will eventually have its own $15,000,000 power plant for mining, milling, and smelting operations.

EASTERN STATES

Callahan Zinc-Lead Company, Inc., operator of lead-zinc mines and mills in Colorado and Nevada, and gold placers in Alaska, is diversifying its operations. It will explore for monazite-columbite and rutile in Aiken County, South Carolina. The government has awarded a DMEA $37,960 contract to them, the government's share being $31,506.80.

The *Bethlehem Steel Company* is constructing one of the world's largest conveyor belt systems at its Lackawanna, New York steel plant. The belt is more than a mile long and is capable of carrying 6,000 tons of iron ore per hour. Being built at a cost of $5,000,000, the system is expected to be completed by next summer. Limestone and iron ore will be transported from the unloading docks to storage yards. The belt is also reversible so that iron ore from the new storage yard can be brought to the furnaces when needed.

An exhaustive study of all coal seams in the Appalachian Mountain region around Fairmont, West Virginia, will be undertaken by the *Pennsylvania Coal & Coke Company* in the hope of finding recoverable quantities of germanium. The mineral ranks with titanium and uranium as a rare but highly essential mineral. It is now in particular demand because of its use in electronics. Much work has been done in England on the recovery of germanium from coal and flue dust. It is reported that the program to be undertaken is in cooperation with the *Eagle Picher Company*, a large producer of germanium.

The *New York Central Railroad* has opened its new $1,500,000 railroad yards at Watertown, New York, to serve the St. Lawrence, Adirondack, and Ottawa division which is the key point in the shipment of iron ore from adirondack mining areas to the steel mills of Pennsylvania. This represents the largest single modernization program ever undertaken by the St. Lawrence division. Facilities are provided for Diesel engine repair, and all steam locomotives have been replaced with Diesel.

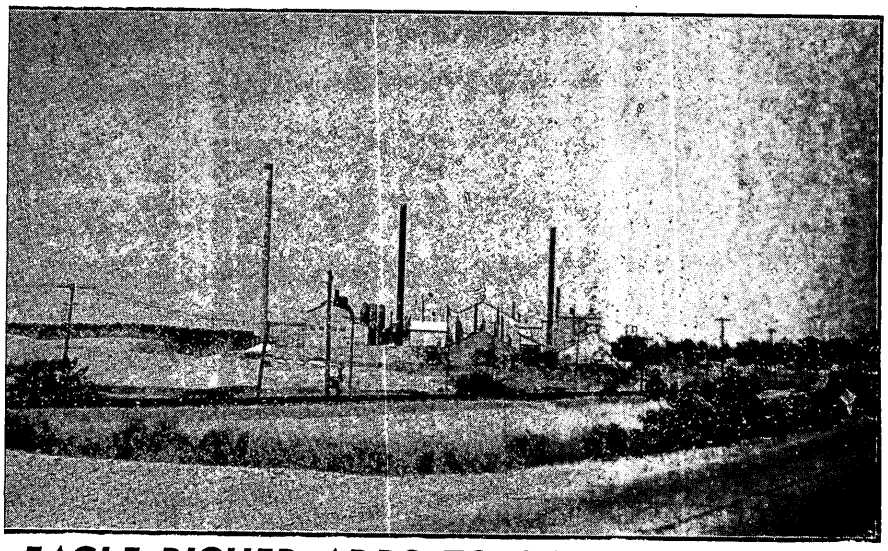
The expansion goal for tungsten ores has been amended. The revised goal, consisting of domestic production plus imports, has been set at 40,000,000 pounds of contained tungsten per year in 1954. (The goal does not apply beyond 1955; this will be determined when the requirements-supply situation is reviewed at a later date.) The present revision provides for an increase of 6,000,000 pounds in the annual rate previously established earlier this year, or an increase of 31,000,000 pounds over the 1950 rate of new supply of 9,000,000 pounds. Domestic production of tungsten concentrates in May and June of this year exceeded consumption for the first time since the third quarter of 1949.

The Defense Materials Exploration Administration has approved a $4,100 loan for *Yancey Mica Mines, Inc.* to explore for mica in Yancey County, North Carolina. The government's share will be $3,690.

Titanium and titanium alloys are being produced by *Republic Steel Corporation* at its steel plants in Canton and Massillon, Ohio. Production is limited and is under strict allocation by the government.

CENTRAL STATES

Operations have started at the first commercial unit in the United States for the recovery of uranium as a by-product of phosphate rock. The unit is a part of the plant of the *Blockson Chemical Company* near Joliet, Illinois. Three other full-scale recovery units are already under construction. *International Minerals & Chemical Corporation* and *Virginia-Carolina Chemical Corporation* are building near Mulberry, Florida, and *Texas City Chemicals, Inc.* is building a recovery unit at Texas City, Texas. All have contracts with the U.S. Atomic Energy Commission.



EAGLE PICHER ADDS TO GALENA SMELTER

The Eagle Picher Company will shortly start construction of a $4,000,000 zinc roasting and sulfuric acid plant at its lead smelter near Galena, Kansas (shown above). Completion is expected during the early part of 1954. Proposed output will be about 240 tons a day of sulfuric acid, the major portion of which is already under contract to the Missouri Farmers Association which plans to construct a phosphoric acid and fertilizer plant nearby. A certificate of necessity has been granted by the Defense Production Administration approving accelerated depreciation of the plant for income tax purposes. The DPA has authorized the company to write off 70 percent of the total cost.

IRON RANGES

Two new open-pit producers on the Cuyuna Range will contribute to 1952 shipments. The *Rabbit Lake* mine at Cuyuna, Minnesota, operated by *Pickands, Mather & Company,* is in the east part of what was once Rabbit Lake before it was pumped out and dredged to make the ore body accessible. The Rabbit Lake deposit contains a substantial tonnage of ore. It is a shovel-truck operation. the *Manuel* mine at Crosby, Minnesota, with an undetermined tonnage, is a *Zontelli Brothers, Inc.* property. With the washing plant completed, the mine will enter the shipping list soon. Zontelli Brothers also operate the *Virginia* mine at Trommald, which was stripped by them in 1947, and have leased the *Gorman* pit at Randall, Minnesota, which the firm stripped under a contract for the *Pacific Isle Mining Company.* Pacific shipped 34,300 tons from the Gorman in 1951.

M. A. Hanna Company mines on the Cuyuna Range in Minnesota are operating on a seven-days-per-week schedule. Stripping is being continued at the *Mallen,* a new mine, while the 7-W. dragline is loading surface material onto the conveyor system at the *South Alstead.* An extension is being built on the beneficiation laboratory at Hanna's *Patrick* mine at Cooley. The finished building will be 30 by 45 feet. At the company's *Buckeye* mine, both stripping and ore washing are being carried on 20 shifts per week. The *Morton* dragline-conveyor system is operating 21 shifts per week. Foundations have been laid at the Morton for the new inclined skip hoist. New equipment for the proposed ore handling system is arriving regularly.

The Office of Price Stabilization granted a 75 cents per ton increase in the ceiling price of merchant ore in the Lake Superior district on September 12. The new base ceilings apply to ore delivered on and after July 26, 1952. They are Mesabi Range non-bessemer, $9.05; Mesabi Range bessemer, $9.20; old range non-bessemer, $9.30; old range bessemer, $9.45; high phosphorous, $9.05.

The *Foundation Company* of New York has ledged the 15 by 21 foot *Cannon* mine shaft of the *Hanna Coal & Ore Company* at 143 feet below the surface. The Foundation Company completed its work about October 1. The shaft was sunk under compressed air pressure with crews working in 45-minute relays. Shaft sinking began last winter.

The *Allis-Chalmers Manufacturing Company* will build a giant crusher for the *Reserve Mining Company's* taconite plant near Beaver Bay, Minnesota. The crusher will be designed to handle 3,500 tons of taconite per hour; will weigh about 550 tons; will have a 5-foot receiving opening; a 9-foot, 1-inch-maximum-diameter crushing cone, and a 27-foot-long, 100-ton main shaft whose maximum diameter will be 4½ feet. The crusher will be driven by two 500-hp. motors and will require more than two years to build.

The *Isle Royal Copper Company,* which began in 1852 and closed down after World War II, is cleaning up the last scrap iron from its property near Houghton, Michigan, and is now liquidating the company.

After having spent nine years dredging the tailings from No. 1 bank in Torch Lake, Michigan, the *Quincy Mining Company* will soon move the dredge to No. 2 bank, because the No. 1 bank is nearly exhausted. From the new location, the tailings must be pumped about 1.1 miles to the reclamation plant. The No. 2 bank tailings were deposited in the lake from 1901 to 1920 and are expected to last about five years.

The *U.S Steel Company's Pittsburgh Steamship Division* set an all-time record when its 64 vessels loaded a total of 1,002,092 gross tons of ore in a one-week period, the first 1,000,000-ton week in the half century history of the Pittsburgh fleet. This was the last weekly period of the 1952 shipping season in which lake ships were permitted to load to maximum draft. The fleet recently set a new all-time record for a month's loading with a total of 3,974,477 gross tons during August.

Work on *Reserve Mining Company's* Beaver Bay, Minnesota, taconite development is progressing. The breakwater is rapidly taking shape, built with rock from the shoreline and a short truck haul. Offices and barracks to house construction workers are being erected, as are buildings for the power plant, workshops, and warehouse. Fifty houses have been moved in from Crystal Bay and are being made ready for employee occupation.

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TITANIUM RESEARCH PLANT SEEKS LOWER COST COMMERCIAL PROCESS

A new development section of the titanium research program being undertaken by the U. S. Bureau of Mines has started operations at Boulder City, Nevada. The section, under the direction of M. G. Mastin, will operate a large-scale production and demonstration plant to supplement the laboratory and smaller-scale work of the titanium research section. The expanded scope of the work is in cooperation with the Armed Services.

Equipment in the new plant includes storage and a purification plant for titanium tetrachloride, a group of conventional batch reactors with accessory equipment for producing, purifying, and handling crude titanium sponge metal, and space for a number of new reactors which are in the experimental development stage.

The Bureau first began laboratory experimental work on titanium at Tucson, Arizona, in 1938. All possible methods were evaluated and it was concluded that a process originally suggested by Wilhelm Kroll offered the best possibilities for further development. The basis of the Kroll process is the reduction of titanium tetrachloride with magnesium in an inert atmosphere, usually helium.

In 1942, the titanium project was moved to the Salt Lake City laboratories of the Bureau, and the technique of production was developed and improved by steps until, by 1944, batches of metal weighing 15 pounds could be produced.

In 1944, the project was moved to Boulder City because this station was equipped for development work on a large scale. Here, major emphasis was placed on regular production of a ductile metal of uniform grade, principally for providing samples to enable industry, educational institutions, and research organizations to study the properties and probable usefulness of the metal. Soon the plant turned out 100-pound batches of metal and produced regularly 150 pounds of processed metal weekly. By 1947 the size of the reactor had been increased to produce 200 pounds of metal per week; by 1949, production in the plant had risen to 800 pounds per week.

Late in 1950, the Bureau's pilot plant facilities were loaned to Titanium Metals Corporation to operate as a producing plant. This arrangement continued for over a year and resulted in the production of over 100,000 pounds of metal badly needed for the defense program. Subsequently, Titanium Metals started production in its own plant at Henderson, Nevada.

In spite of extensive research programs sponsored by private and government agencies over the past five years, the Kroll process is still the only commercial one for producing material that can be processed to massive, ductile metal. Sponge titanium metal is quoted at $5.00 per pound, and fabricated materials, such as thin rolled sheets, bring as much as $15.00 per pound. Efforts are constantly being directed by the Bureau toward reducing the cost of producing and fabricating titanium. Experiments performed in the research section that look promising or hopeful will be continued on a larger scale in the new development section, where their potentialities and processing cost can be appraised on a scale of from 400 to 2,000 pounds of metal per day. The metal produced in this plant will go elsewhere for further testing in its fabrication and application.

Anaconda Makes Progress At Yerington Project

The Anaconda Copper Mining Company is stripping 40,000 tons of overburden per day from its Yerington orebody, according to A. J. Gould, plant superintendent. Three, 5-yard electric shovels and a fleet of 25-ton, Diesel-powered trucks are used in the new pit. Mineralized, but below-ore-grade, overburden is being stockpiled separately for possible heap leaching at a future date. Waste from the pit area is trucked to the waste dump area adjacent to the pit.

Pouring of concrete for the new crushing and metallurgical plant started in July. Production of copper precipitate from the new project is scheduled for late in 1953, and will be at an annual rate of 60,000,000 pounds for the first two years of production and 66,000,000 pounds annually thereafter.

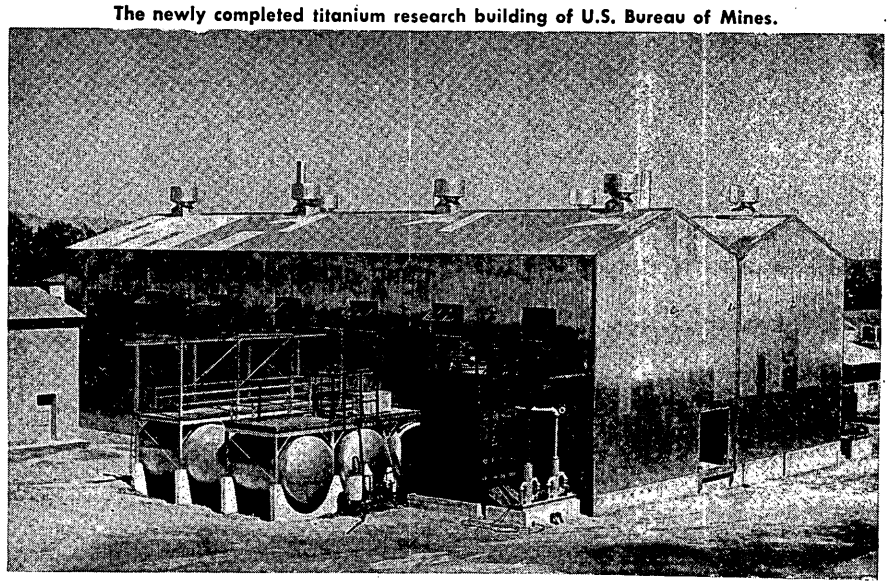
The Isbell Construction Company has been awarded the contract for the 12 miles of access road to be built from U.S. Highway 395 to the Leviathan sulphur mine in Alpine County, California. The sulphur property is a distance of about 60 miles by road from Yerington. Isbell has also been awarded the stripping contract and has commenced stripping of overburden from the sulphur deposit which will be mined by open-pit methods. The 30-percent sulphur ore will be trucked to Yerington and burned in fluosolid reactors to form SO_2 gas used in a contact sulphuric acid plant. The acid will be used to leach the oxide copper minerals in the ore.

Wiechmann and Probasco, Inc. of Reno, have completed the 235 one-, two-, and three-bedroom houses that the company had built to rent mine workers in Nevada's newest community—Weed Heights. In addition, 16 dormitories and a mess hall have been finished to accommodate 100 single men at the project, and construction of recreation facilities is underway. More than half of the new homes are occupied.

ARIZONA

The *Reorganized Silver King Divide Mining Company* is dewatering the 600-foot, or bottom, level of its *Mount Union* mine, near Prescott, Arizona. In the past year and a half, the company has driven a 1,200-foot tunnel which cut the old shaft at the 515-foot level and permitted the draining of old workings. Two ore shoots, 80 to 100 feet in length and 2.0 to 4.0 feet wide, have been opened on the 400 and 500 levels. Plans are now being made for erection of a 50-ton mill for treatment of the lead-zinc-gold-silver ore. H. R. Bissell of Prescott, is manager of the company. At the annual meeting of stockholders in September, the name of the firm was changed to *Mt. Union Mines Inc.*

The newly completed titanium research building of U.S. Bureau of Mines.



Exploration work at the *Morning Star* tungsten mine, in the Old Hat mining district, near Oracle, Arizona, has been started by the *Nikas Mining Company*. A crew of 10 men is already employed in the preliminary work. According to John Gekas, director of the company, the Defense Minerals Exploration Administration has granted the company a $60,000 exploration loan for the project. The Nikas group leased the Morning Star a year ago from Mrs. Elizabeth Woods. Some test mining was done and the ore hauled to the Goldfield mill near Apache Junction, the resulting concentrates being sold to *U. S. Vanadium Company* at Bishop, California. Mining was from tunnels and open cuts, and the ore vein was said to run from 5 to 18 feet in width. Harry E. Krumlauf of Tucson is consulting engineer.

The *Globe-Maimi Copper Zinc Corporation* has purchased the assets of the *Comstock Extension Mining Company, Inc.* of Globe, Arizona. Comstock holdings included the old *Irene* and *Doughboy* properties, both of which have been developed extensively during their 50-year history. It is reported that under terms of the contract of sale more than $500,000 is to be made available for complete development of the property. Officers of purchasing company include James U. Fagan, president, Phoenix; and Russell A. Wright, secretary-treasurer, New York City. Tony Trojanovich, one of the former owners, will serve as mine manager. The sale was handled by the *Bonded Realty Company* of Phoenix, mining brokers.

The *Dutch Flat* group of mines near Yucca, Arizona have been purchased by Birt J. Jackson and Duean Vaal'duean of Yucca. They are now overhauling the water system and building roads. Installation of a small Straub mill is planned for the future as a pilot mill. First work will be on the tungsten deposits.

The Defense Materials Procurement Administration has opened a depot at Wenden, Arizona for the buying and stockpiling of manganese ore. A small sampling mill is part of the installation. Government specifications call for ore with a maximum copper-lead-zinc content of 1.0 percent, of which not more than 0.25 may be copper. Ores with a higher lead and zinc content will be accepted if such ores can be nodulized and upgraded to meet these specifications. Producers have until August 31, 1953 to apply for permission to deliver ore to the depot. The program continues until June 30, 1956, unless ore containing 6,000,000 long-ton units of manganese is purchased sooner.

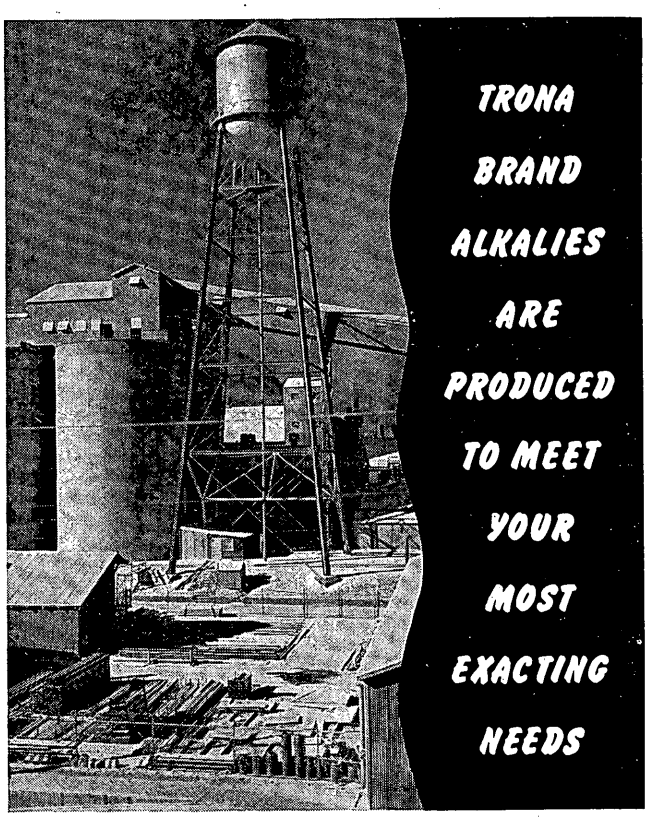
A new, four-year $4,000 scholarship has been established by *Inspiration Consolidated Copper Company* of Inspiration, Arizona. Eligibility for the scholarship is limited to graduates of Globe and Miami (Arizona) high schools, with preference given to candidates who are sons or daughters of employes of Inspiration. According to P. D. I. Honeyman, vice-president and general manager of Inspiration, the new scholarship will be an annual award. The $4,000 will be made available in annual stipends of $1,000 each, to an incoming freshman in the college of engineering or the college of mines, University of Arizona. The $1,000 stipend is renewable during each of the next three years of the student's academic career, upon maintenance of a satisfactory scholastic standing. The initial award went to Edward W. Hinderberger, Jr., 17, a graduate of the Globe high school and who entered the university this year as a freshman.

About 1,000 feet of development work has been done during the past year at the *Catoctin* mine, 12 miles south of Prescott, Arizona, the work consisting of tunnel, crosscuts, and drifts. This work is to be continued in an effort to prove sufficient ore to justify mill construction. C. W. Gabrielson of Prescott, Arizona, is general manager.

CALIFORNIA

The *Holmestake-Mining Company* of Winterhaven, California, is operating the *Cargo Muchacho* group of claims in Imperial County, California. Recent developments in the mine have indicated commercial deposits of tungsten and the company is hoping to revamp its mill for treatment of tungsten ores. The Cargo Muchacho, originally operated as a gold producer, is equipped with a 100-ton cyanide mill. Kenneth Holmes is president and manager of the company.

A large strike of exfoliating vermiculite has been found near Jacumba, in San Diego County, California, by Kenneth J. Hines. A bulldozer is reported to have proven the deposit to be large. At the present time, trenching or crosscutting is taking place. So far as can be determined, the main deposit striking northwest and



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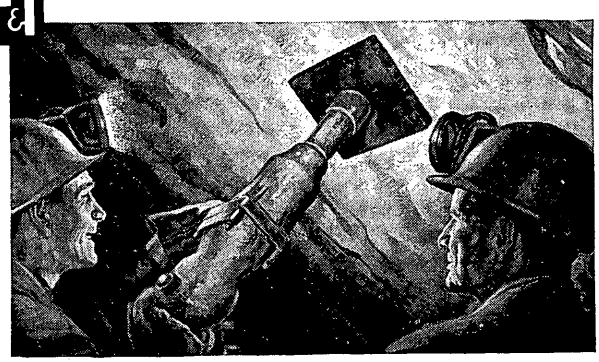

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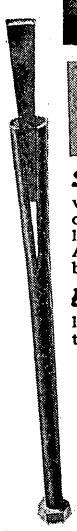

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southeasterly is over 100 feet in width, with a paralleling deposit of unknown width. All road work has been completed and the mill is being refurbished.

The *E. J. Longyear Company* is studying the mineral deposits at the *Bully Hill* mine located on the Squaw Creek arm of Shasta Lake in northern California. The property which has been inactive for the last 25 years, is now owned by the *Glidden Company*. Diamond drilling started last December on a series of 1,000-foot holes. The crew is working on a 24-hour basis to drill 35 such holes on the property. Only about five have been completed to date. The property is a former gold, copper, and zinc producer.

The *Alaska* gold mine located in Sierra County, California, near Pike City, has closed down and equipment is now being dismantled.

The *Minona Mining Company* is operating a dragline dredge on a 1,300 acre tract said to contain 1,600 feet of a gold-bearing channel at the old *Esperance* mine near French Corral, California. The property is estimated to contain about 20,000,000 cubic yards of gravel, free from lava overburden and surface material which were removed years ago by hydraulic mining.

The *Hazel Creek Gold Mining Company* is considering sinking a shaft and conducting extensive deep exploration and development work at its *Hazel Creek* mine in El Dorado County, California. Mining is presently conducted through a 500-foot tunnel which has developed the ore body to a depth of about 250 feet. The mill has a 25-ton-per-day capacity, producing a lead-gold concentrate which is shipped to the *American Smelting and Refining Company's* smelter at Selby, California.

A ball mill has been added to the reduction plant of *Sarita Milling Company* at its *Sarita* gold mine in the Masonic district of Mono County, California. The company also operates the *Chemung*, the *Pittsburgh-Liberty* and other gold properties in the county. The Sarita is said to contain about 100,000 tons of ore, mined from an open pit.

NEVADA

A commercial sulphur deposit reportedly has been discovered near Beowawe, Nevada. Oscar J. Streeter and Pete Peterson of Elko are said to have uncovered about 400 tons of sulphur with indications that the deposit contains about 100,000 tons. They also have moved power loaders and a bulldozer to the *Summit View* mine in Corral Canyon, south of Harrison Pass. They expect to ship silver and lead from there soon.

The *Riley* mine, closed since December 1947, has been reopened and is producing tungsten again. *U. S. Vanadium Company* is owner of the property which is located in the Potosi district about 42 miles northeast of Winnemucca, Nevada. John Etchart has a contract with U. S. Vanadium to mine and haul the ore to the mill of *Getchell Mine, Inc.*, where it will be custom-milled. The concentrate will then be shipped to U. S. Vanadium's synthetic scheelite plant near Bishop, California for processing.

Manganese, Inc.'s new 1,200-ton mill at the *Three Kids* mine near Henderson, Nevada, is now in production and is processing a 280,000-ton stockpile of 22 percent manganese dioxide ore. The stockpile was built during World War II for the *Metals Reserve Company*. The manganese dioxide is crushed, concentrated by flotation, calcined in huge kilns, and nodulized to a metallurgical grade of 45 percent manganese or better. The product is shipped to various destinations as ordered by the General Services Administration.

Kaiser Aluminum & Chemical Corporation's new fluorspar flotation mill has been completed near Fallon, Nevada. The mill will process about 100 tons of ore daily, from which about 30 to 50 tons of concentrates will be produced. The concentrates will be shipped by rail to Nichols, California for further treatment. Fluorspar will come from the *Baxter* mine near Gabbs, which was purchased several months ago. Preparatory work has been going on in the mine and it is now ready for production.

The *Consolidated Eureka Mining Company* operating at Eureka, Nevada is extending its Diamond tunnel 100 feet to the west to cut a station from which diamond drilling may be carried on. The property produced substantial lead-silver tonnages in earlier operations.

Foley Brothers, Incorporated has resumed normal sinking of the Deep Ruth Shaft at Kimberley, Nevada. Sinking of the 1,600-foot-deep shaft has been slow and difficult due to the sudden and unex-

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pected inflows of water. In one instance, 15,000 gallons per minute flooded the shaft necessitating the placing of a concrete seal under 200 feet of water. Roy Hickman is job manager for Foley Brothers who are sinking the shaft, driving 9,000 feet of main haulageway, and 16,000 feet of ore transfer raises for the Nevada Mines Division of *Kennecott Copper Corporation.*

The Defense Materials Procurement Agency has authorized a field investigation of the tungsten potential in the Ely, Nevada region. The survey will be made by government geologists and mining engineers. Some promising scheelite deposits have been found in this area.

A shaft being sunk by the *Alpine Mining Company* at its *Noonday* mine in Nevada is down 75 feet and nearing its initial objective. At the 100-foot point, it is planned to open stopes for mining of shipping-grade, lead-zinc-silver ore. Progress is slow because of the fractured rock formation. The two-compartment, 9 by 6 foot shaft is being sunk at the rate of two feet a day. Construction of a flotation plant is planned for the future.

Development work reportedly is going ahead steadily at the *Ward* mine in White Pine County, Nevada. Located some 17 miles south of Ely, the property is being operated through a joint agreement by *Buffalo Consolidated Mining Company, Golden Centuries Industries, Inc.,* and the *Walker Corporation.* Work is in the Mountain Pride tunnel and the Lower Defiance tunnel, each driving toward a different ore body. Two carloads of ore have been shipped with values in gold, silver, copper, and lead. The new operators have done much rehabilitation work, including road building, cleaning out of old workings, and installation of new machinery. "Bud" Walker of Ely is in charge.

The *New World Exploration, Research and Development Corporation* is now operating the *Alladin* mine near Elko, Nevada, shipping about one carload a day of high-grade lead-silver-copper ore to the *American Smelting and Refining Company's* lead smelter at Selby, California. Diamond drilling is under way to block out additional tonnages for future shipment. The corporation is also engaged in exploration of a tungsten deposit at Bullion, Nevada, in Elko County. They are presently driving an exploration raise to determine the extent of a medium-grade ore body. Negotiations have just been completed by the corporation for a lease on the Ruby Valley barite deposit of Moore and Griffith. A geological examination has been completed and a diamond drilling crew is now drilling the area to determine grade and tonnage.

The *Fowler Mining Company* has been organized and incorporated in Carson City, Nevada, with a capitalization of $100,000. Earl S. Fowler is president; Howard Molini, vice president; Alice M. Fowler, secretary; John Molini, treasurer; Arlie Roy Eubanks, second vice president; and Earl Lee Eubanks, director. The firm is working a property located near the Esmeralda County-California line. Showings are in lead and silver ore.

The most powerful copper mine hoist in the United States is being built by the General Electric Company at Schenectady, New York for a block-caving mine operation at *Kennecott Copper Company's Deep Ruth* mine in Nevada. Two 660-volt d-c motors, with a combined rating of 3,300 hp. at 500 rpm, comprise the drive which will power the hoist. The hoist itself, being built by the Nordberg

(*Continued on page* 100)

Statement of Ownership

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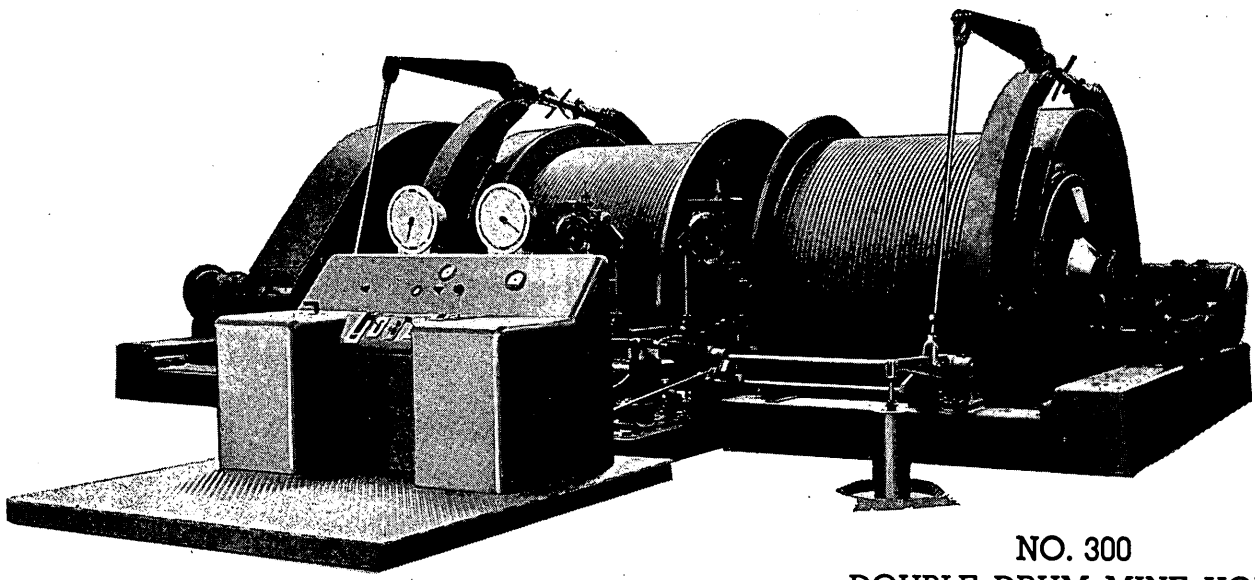

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Beartown

(*Continued from page* 50)

bedsteads and with a big iron range in the kitchen. While some of the buildings were fairly new (for the mine was working about 15 years ago), others dated from 1900 and still others from the 1890's when the vein was first opened and when eight burro-loads of ore were taken from it over to Utah to be smelted. This mine is just below timberline. Above it, on the bare rock slopes, studded with patches of old snow, are the dumps of the Good Hope and the Yankakee, the Gold Bug and the Silver Bug.

Beartown was flourishing in 1894 and for several years thereafter. Old prospectors who staked claims in 1893 and had gone out for the winter started early to outfit for the new season. Both A. L. Miller, the proprietor of the stage line between Bachelor and Creede, and Ridenour and Shelhomer, who ran a line of vehicles from Spar City to Creede, prepared to put on stages to the new camp high in the San Juans.

The impatient miners who had gone out for the winter, and others who were arriving for the first time in the spring of 1894, were eager to get to the camp as soon as possible. Although snow lay deep on the trail for miles below the place, they broke trail as far as they could, and then, rather than wait for the snow to melt in Gold Run Park, as Beartown was also called, these early comers laid out a new townsite where the Rio Grande, Bear and Pole Creeks join and called their camp Junction City.

By the middle of April, the new town contained 40 cabins with stores and saloons open for business. The *Candle* of April 27 described the place as "five miles from the mines in a pretty park, level and affording ample room for town building. . . . Junction City is the outcome of the rush which started from Creede, Bachelor, and Salida early last week. . . . A meeting of the settlers was held and it was decided that all prospectors and their grubstakers should have first choice of lots and be entitled each to one business and one residence lot."

After exploring the site of Beartown in 1948, and scrambling up to the shaft holes and snow-warped sheds which mark its once-rich mines, I rode back five miles down Bear Creek valley, looking for any remaining traces of Junction City. All I found was one old weathered and decrepit cabin.

After reclimbing Timber Hill, I looked to the west, across the high open country, to Stony Pass, a saddle south of a bare, rocky peak. Over its grim ribs, a tidal wave of miners swept into the rich mineral country which had been torn from the Indians as soon as Felix Brunot had negotiated a treaty with the Utes in 1873.

Nothing but the craze for gold could have kept the stream of miners clambering over range after range without roads or trails other than those made by Indians or worn by wild animals. Even when trails were blazed by the impetuous men, they were almost impassable; the first roads constructed were little better. During the 1870's the gateway to the San Juan area was over Stony Pass, 12,090 feet above sea level. From Del Norte, men followed the Rio Grande valley, past Antelope Park, to the headwaters of the river, and crawled over Stony Pass and down Rocky Gulch on the other side to Baker Park. Until a wagon road was built in 1879, people left their wagons in a park above Wagon Wheel Gap on the Rio Grande, packed their equipment on burros, and fought their way up over the pass and down Cunningham Gulch to Silverton.

For years W. D. Watson ran a "roadhouse and stopping place for man and beast" at the foot of Grassy Hill on the east side of Stony Pass. All summer hundreds of pack animals were turned out to graze on the green slopes before sundown, while the weary miners and freighters rolled up in their blankets for a night's rest before tackling the difficult climb over the range.

In June 1877 the citizens of Silverton "turned out in force" to open the road to Antelope Park. "While working in old snow, 12 feet deep, two snowstorms occurred, deposting 16 more inches of the beautiful" and materially hampering their work.

Even when the road was built, it was rough and difficult. It crossed the pass 500 feet higher than the trail and the descent to Howardsville on the far side was steeper than the eastern face, dropping 2,300 feet in the first two miles down Rocky Gulch. Yet over this pass the prospectors and settlers went in and the pack trains of ore went out. In winter it was closed except for such pieces of mail as could be packed over it on the back of a carrier on snowshoes.

The year the road over the pass was opened, Silverton, with its many frame cabins and flimsy tents, decided that it needed fire protection and ordered a "hook and ladder truck with necessary equipment" sent to the isolated mountain town. The truck was delivered at Grassy Hill where it was met by nearly half the male population of Silverton and hauled by hand over the summit of the pass and down into town. It was preceded on the last leg of the journey by the Silverton Cornet Band, and in the evening a big dance was given in its honor.

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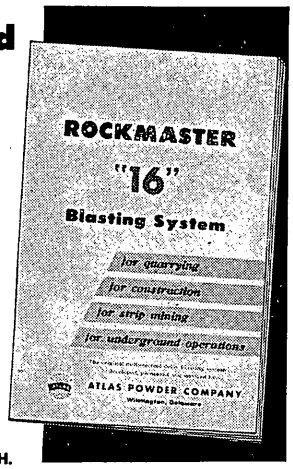

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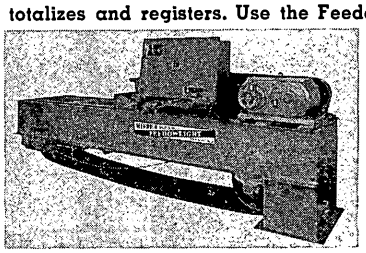

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Southwest News

(*Continued from page 97*)

Manufacturing Company, will hoist two skips arranged in balance and weighing 21,000 pounds each. When operating from the maximum depth, the hoist will be capable of delivering 12 tons of copper ore to the surface every 72 seconds. GE is also building a 600-hp. drive for a Nordberg man-and-materials hoist at the same mine. This drive will be powerful enough to raise a double-decked cage at a rate of 1,200 feet per minute.

NEW MEXICO

Howard I. Young, assistant administrator of the Defense Materials Procurement Agency, will be one of the principal speakers at the Southwest Mineral Conference to be held in Albuquerque, New Mexico, November 6, 7, and 8. He will report on defense minerals activities. The conference is sponsored by the New Mexico Mining Association and the Southwest International Mining Association.

The *Kennecott Copper Corporation* has closed two of its lead-zinc mines in Grant County, New Mexico because of the recent drop in the price of zinc. The Oswaldo No. 1 and No. 2 shafts near Santa Rita were closed because the present 13½-cent-per-pound price for zinc makes operations unprofitable. About 160 men will be affected but according to William H. Goodrich, general manager of Kennecott's *Chino Mines Division*, none of the men will be laid off. Skeleton crews will be maintained, and the other employes will be moved to Kennecott's huge *Santa Rita* open-pit copper mine which is producing at capacity. No other major zinc producer in Grant County has reported plans to curtail operations.

New Mexico's mining industry in the fiscal year that ended June 30 broke all previous records. State mine inspector John Garcia's annual report shows minerals valued at $99,648,584 were produced—an increase of $9,926,628 over the previous year, the last record made. Although there was a decrease of 1,253 tons as compared with the previous year, copper production again led the metallics, reporting a volume of 73,954 refined tons valued at $35,767,417. The decrease is attributed to a two-week work stoppage in February which affected major producers in Grant County. Provided the present demand for copper continues, the price remains at the present level, and no work stoppages occur, copper production should be in the neighborhood of 75,000 tons for the present fiscal year.

The Defense Minerals Exploration Administration has approved a $20,000 contract for the *Black Hawk Construction Mines Company* of Silver City, New Mexico to explore for cobalt-uranium in Grant County, New Mexico.

The *Portales* mine and the open-pit *Malachite-Julian* mine of the *Mex-Tex Mining Company* each have been trucking about 150 tons of ore daily recently from Hansonberg mining district of New Mexico to their respective mills in San Antonio, New Mexico. The Portales mill produces galena, the Mex-Tex mill barite, galena, and fluorite.

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1—40 Ton Fairbanks Scale with Mauer weighing beam

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2—20 HP Gen. Elec. Slip-ring 1200 RPM
1—30 HP West. Slip-ring 840 RPM
1—35 HP AC Slip-ring 850 RPM
4—1 HP West. Squirrel Cage 1200 & 1800 RPM
1—2 HP Louis-Allis Squirrel Cage 1140 RPM
5—5 HP Gen. Elec. Squirrel Cage 860 to 1800 RPM
2—10 HP Gen. Elec. BB Squirrel Cage 1160 RPM
5—15 HP Gen. Elec. BB Squirrel Cage 1160 RPM
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1—Butchart Concentrating Table
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1—Jeffrey Dry Reagent Feeder, Vib. Type
1—18" Denver Cone Dry Reagent Feeder
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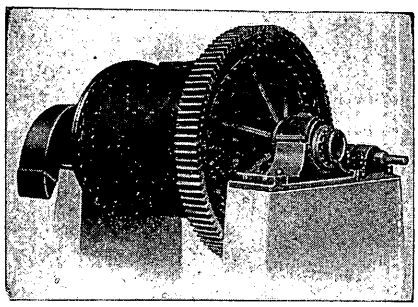

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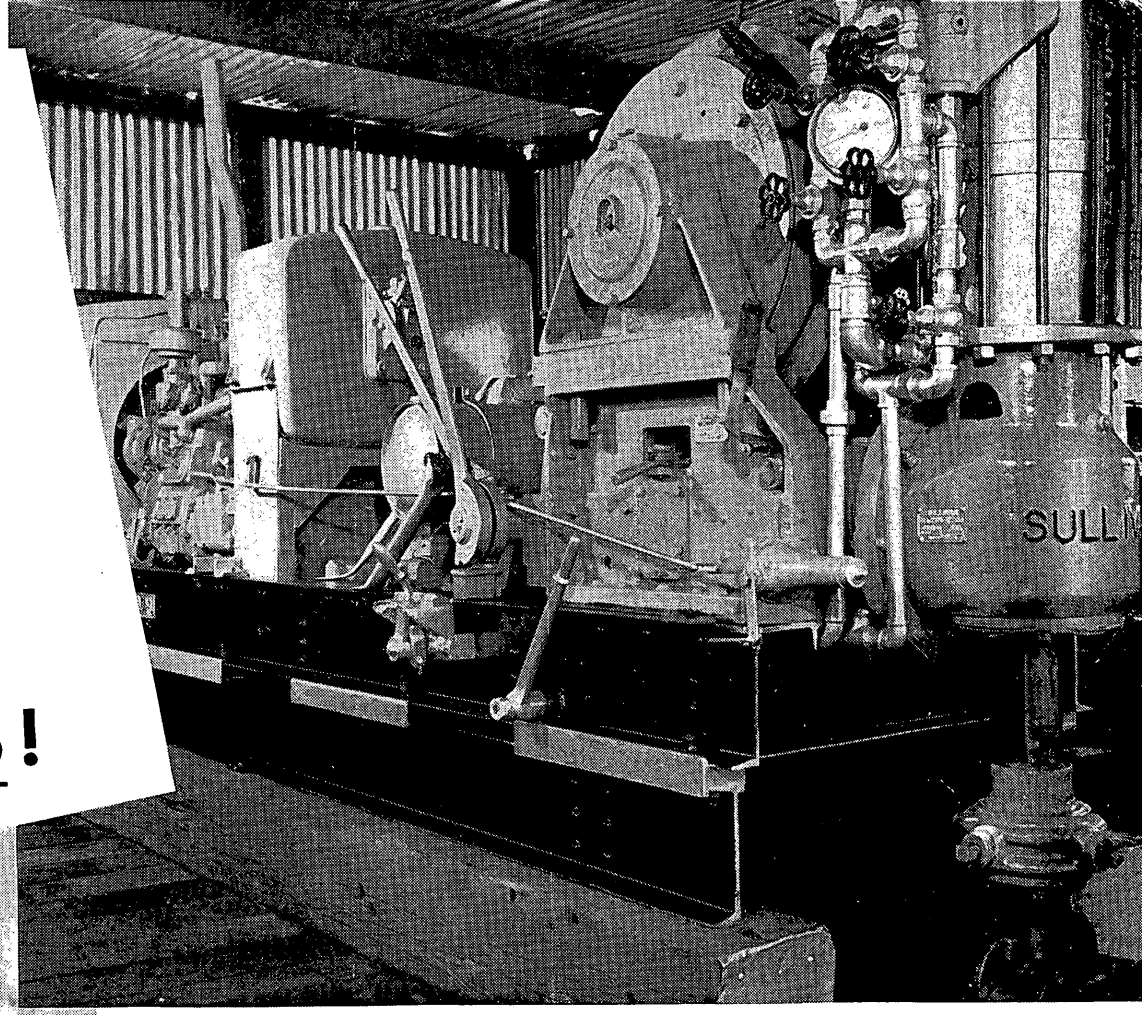

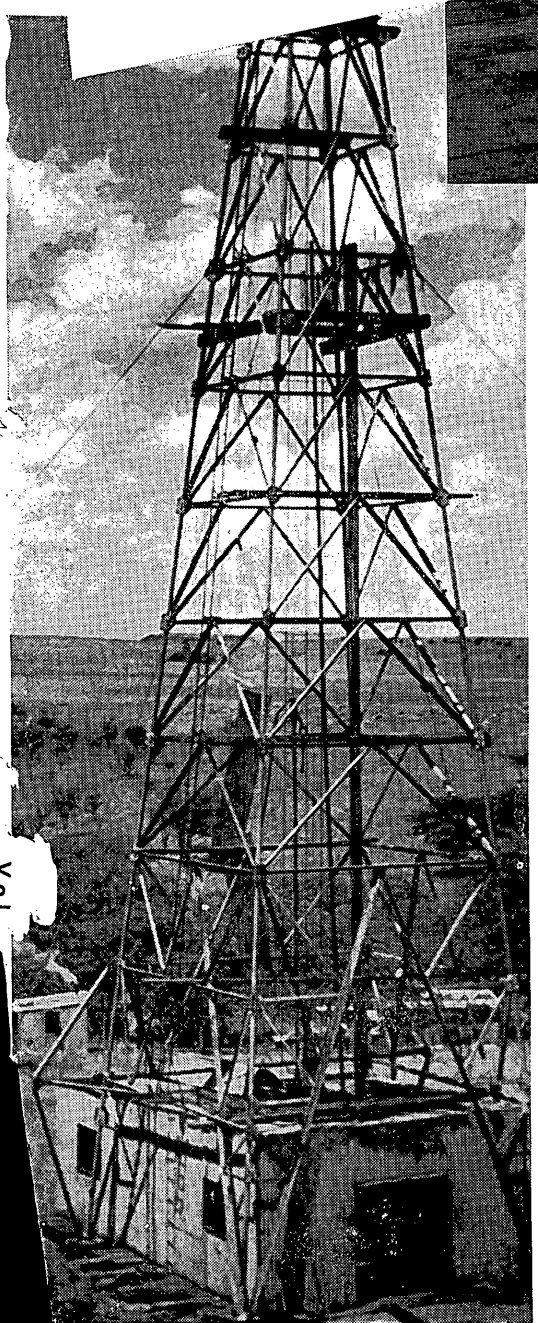

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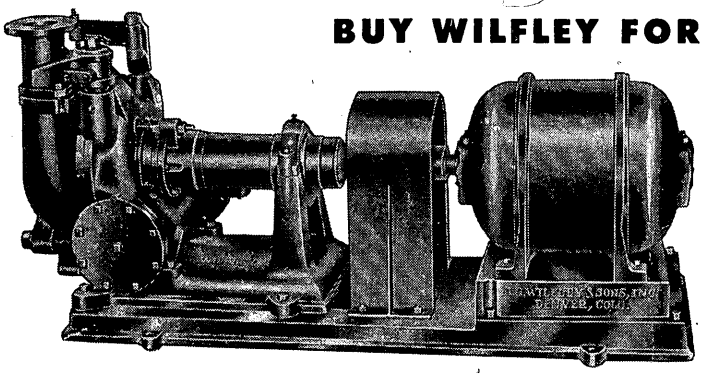

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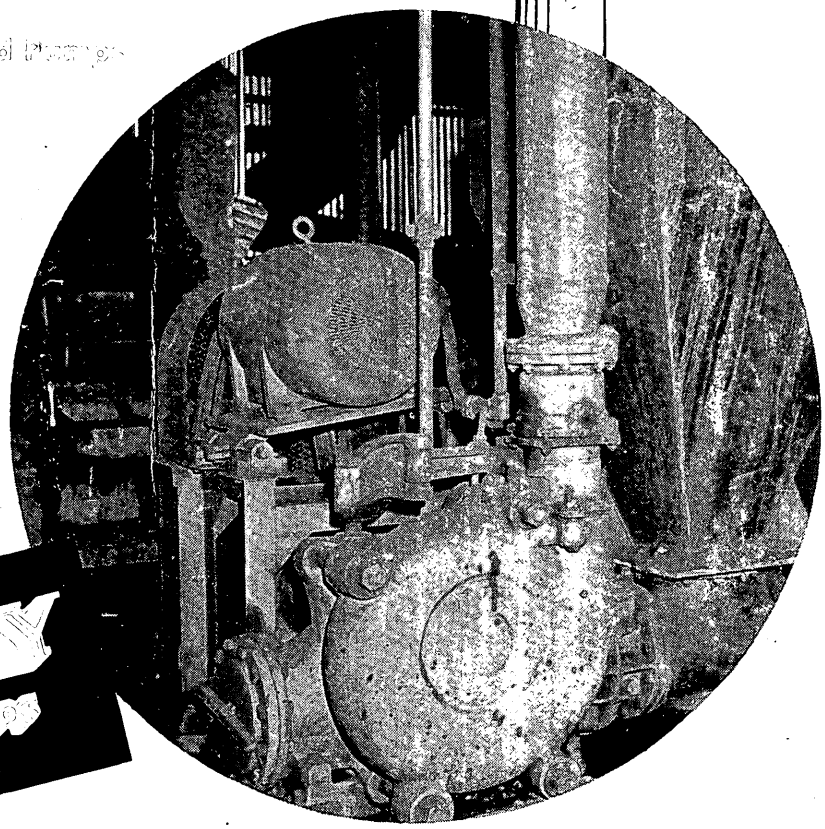

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THE TIN-SPODUMENE BELT OF THE CAROLINAS

A PRELIMINARY REPORT

By T. L. Kesler

ABSTRACT

Cassiterite and spodumene, of possible economic importance, occur in a belt, 24.5 miles long and 1.8 miles in maximum width, extending southwestward from Lincolnton to Grover, N. C. This belt is in the Piedmont province, an upland with an average altitude of 1,000 feet, and is readily accessible by rail and highway. The region is underlain by crystalline limestone, quartzite, schists, gneisses, and granite. The rocks strike northeast and, in most of the belt, dip steeply northwest. Most of them are deeply weathered.

The tin-spodumene belt lies mostly in North Carolina between Lincolnton and the State line. Cassiterite occurs sparsely in hundreds of spodumene-bearing pegmatite bodies, which were emplaced in joints where the rocks are uniformly competent, and parallel to the layering where competent and incompetent rocks are interlayered. Locally, cassiterite is sufficiently abundant in the pegmatite bodies and in closely associated greisen (quartz-muscovite rock) to be of possible commercial value. There are at least 91 such deposits of potential tin ore in North Carolina, and 1 near Gaffney in South Carolina.

The deposits vary widely in thickness along their strike and dip; about 18 are more than a foot thick. The maximum strike length is 275 feet. Little is known about the downward extensions of the bodies, but irregular shapes and unpredictable dimensions are to be expected. The tin content of the ore ranges in general from a trace to more than 6 percent, and the grade in any one deposit is likely to be far from uniform. Records of production from the Ross mine, near Gaffney, indicate that its ore averaged possibly 2 percent of tin; this is probably exceptional. Small placer deposits, of which three are known, and thin cassiterite-bearing soils of small extent, might yield 150 tons of metallic tin, but these deposits are likewise low in grade.

Because of their small size, low grade, and scattered distribution, the deposits are not being mined at present, and it seems unlikely that any now exposed could be mined profitably unless the price of tin became extremely high.

Many of the pegmatite bodies contain 15 percent or more of spodumene, and unusually rich parts of bodies average from 30 to 50 percent. The commercial possibilities of the spodumene probably exceed those of the cassiterite, and it is estimated that two unusually favorable areas contain a reserve of at least 650,000 tons of spodumene (more than 20,000 tons of metallic lithium) to a depth of 100 feet.

INTRODUCTION

The tin-spodumene belt of the Carolinas is a long and narrow strip of the southeastern Piedmont (see fig. 27) that contains many bodies of tin- and spodumene-bearing pegmatite. The belt lies about 50 miles east of the Blue Ridge and 85 miles west of the Fall Line. The Piedmont is a moderately dissected upland having a general altitude here of about 1,000 feet. A few ridges and peaks consisting of unusually resistant rocks rise above this level; an irregular ridge known as Kings Mountain which lies 2 miles east of the belt, near the town of Kings

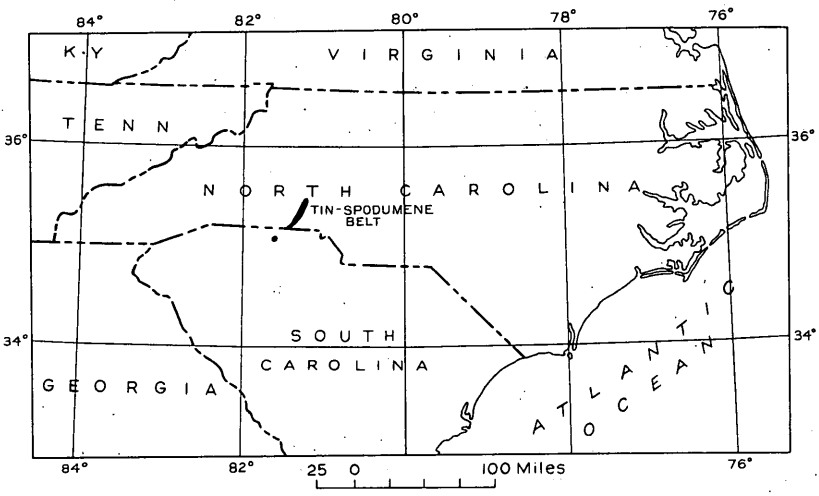

Figure 27.--Index map showing location of the Carolina tin-spodumene belt.

Mountain, reaches an altitude of 1,705 feet. (In this report the name Kings Mountain refers to the town and not the ridge.) The belt is drained by the South Fork and Broad Rivers. Most of it is cultivated, but steep slopes and rocky areas, such as those underlain by the pegmatite bodies described below, are wooded.

Paved highways between the towns and villages, and interconnecting, well-graded roads make the entire region accessible.

From Kings Mountain southward to the State line, the main line of the Southern Railway and U. S. Highway No. 29 run parallel to the belt and less than a mile west of it. Lincolnton is served by the Seaboard Airline Railroad.

Most of the hundreds of pegmatite bodies contain a little cassiterite together with spodumene and other minerals that are not found in the pegmatites of the surrounding region. Locally, in the pegmatite and in greisen (quartz-muscovite rock) associated with it, cassiterite is abundant enough to be of possible commercial value. It is only these relatively rich occurrences of cassiterite that are referred to in this report as deposits. Deposits, in this sense of the word, occur at short intervals from a point 2 miles southeast of Lincolnton to a point 0.8 mile due east of Grover, N. C., very near the State line, and coincide with the occurrence of spodumene. The length of the belt is 24.5 miles, and the maximum width, southeast of Crouse, 1.8 miles; the belt contains at least 91 deposits of possible commercial grade, most of which, however, are very small. The only known tin deposit in South Carolina occurs 12 miles to the southwest, near Gaffney, in a pegmatite that apparently contains no spodumene.

Field work and acknowledgments

The field work on which this report is based comprised (1) detailed plane-table mapping of six local areas in the belt (four of which are outlined on plate 38), and (2) reconnaissance examination of the remainder of the belt and of areas extending 6 miles beyond the extreme occurrences of cassiterite at Lincolnton and Gaffney. Most of the work was carried on during the months from October to May inclusive in 1938-39 and 1939-40, but some field work was done as early as August 1938 and as late as April 1942. The plane-table work during the first season was done largely by P. M. LeBaron, R. A. Edwards, R. M. Barbour, and

H. E. LeGrand, that during the second season by H. E. LeGrand and J. C. Morris. LeGrand and Morris also made most of the reconnaissance examinations of deposits lying outside the areas mapped in detail.

Helpful discussion and advice on specific problems were contributed by W. T. Schaller and C. S. Ross, though the interpretations presented are those of the writer. Charles Milton identified columbite-tantalite, tin-bearing rutile, molybdenite, and a complex group of supergene phosphates and oxides. H. G. Ferguson, F. C. Calkins, W. C. Smith, and T. B. Nolan reviewed the manuscript, and made numerous helpful suggestions.

Previous work

Material relating to the geology, mineralogy, and economic development of the tin deposits and associated spodumene is contained in 44 reports, articles, and maps. The more important of these are listed in the following annotated bibliography.

(1) Dabney, C. W., Jr., Note on cassiterite from Kings Mountain, N. C.: Elisha Mitchell Sci. Soc. Jour., 1883-84, pp. 79-81, 1884.

The first published account of the discovery of cassiterite in the belt; contains two analyses of the mineral that erroneously list tungsten as a constituent.

(2) Furman, J. H., The tin deposits of North Carolina: New York Acad. Sci. Trans., vol. 8, pp. 136-145, 1889.

An illustrated account of observations on the geology of the belt by the first, and one of the most active, prospectors. Contains useful facts, together with doubtful interpretations.

(3) Ledoux, A. R., Tin in North Carolina: Eng. and Min. Jour., vol. 48, pp. 521-522, 1889.

A record of the general results of tin prospecting by open cuts, shafts, and diamond drilling in a portion of the belt about 2 miles long, presumably southwest of Kings Mountain.

(4) Pratt, J. H., and Sterrett, D. B., The tin deposits of the Carolinas: North Carolina Geol. Survey Bull. 19, 62 pp., 1904.

Describes the deposits and discusses their origin.

(5) Graton, L. C., A reconnaissance of some gold and tin deposits of the Southern Appalachians: U. S. Geol. Survey Bull. 293, pp. 31-57, 1906.

Gives a good account of the discovery and early prospecting of the deposits, detailed descriptions of the Jones, Faires, and Ross mines, and an estimate of the total production of the belt to May 1905. Pegmatites of various compositions, interpreted in the present report as the product of successive mineral-bearing solutions that circulated with various degrees of freedom, were regarded by Graton as representing a genetically related series of intrusions.

(6) Sloan, Earle, Catalogue of the mineral localities of South Carolina: South Carolina Geol. Survey, ser. 4, Bull. 2, pp. 85-93, 1908.

Describes and illustrates workings and geologic features at the Ross mine, and records the total production of concentrates from pegmatite and placer to December 1906.

(7) Keith, Arthur, and Sterrett, D. B., Tin resources of the Kings Mountain district, N. C. and S. C.: U. S. Geol. Survey Bull. 660-D, pp. 123-146, 1917.

A general discussion of the geology of the region, with descriptions of the principal mines and prospects, most of which were abandoned at the time.

(8) Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Gaffney-Kings Mountain folio (No. 222), 1931.

Contains part of the economic material in Bulletin 660-D, but is considerably more specific in treatment of geology. The folio does not recognize the genetic relation, found in the present study, between schistose crystalline limestone and the gneisses and schists that enclose the pegmatite bodies.

(9) Fraas, Foster, and Ralston, O. C., Beneficiation of spodumene by decrepitation: U. S. Bur. Mines Rept. Inv. 3336, 13 pp., 1937.

The natural α spodumene in pegmatite matrix, heated to 1,050° to 1,180° Centigrade, was converted to β spodumene, which was selectively disintegrated by gentle grinding and separated from the coarser quartz and feldspar.

(10) Boyd, J. E., Jr., Pyrometric properties of spodumene-feldspar mixtures: Am. Ceramic Soc. Jour., vol. 21, pp. 385-388, 1938.

Fusion tests of mixtures containing 20 to 40 percent of spodumene with either potash or soda feldspar showed that P. C. E. values were lowered several cones below those of the feldspars alone. The addition of spodumene to a mixture of equal parts of the feldspars showed even greater contrast. The paper includes an analysis of the spodumene, which is quoted on page 269.

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(11) Hess, F. L., The spodumene pegmatites of North Carolina: Econ. Geology, vol. 35, pp. 942-966, 1940.

Discusses the origin of the pegmatite in the tin-spodumene belt and the quality and possible amount of the spodumene. Some of the pegmatite minerals are believed to have been deposited, in several stages, by solutions that circulated through fractures in assumed prelithium, granitic pegmatite, whereas, in the present report, all of the minerals are believed to have been deposited by solutions in successive stages, but in different order, and an "original" pegmatite is not postulated.

(12) Norman, James, and Gieseke, E. W., Beneficiation of spodumene rock by froth flotation: Am. Inst. Min. Met. Eng. Tech. Pub. 1161, (Mining Technology), 9 pp., April 1940.

Samples of spodumene-bearing pegmatite from two localities were ground and treated with solutions of NaOH and NaOH with Na_2S to remove films of weathering products from the mineral grains. The films interfered with the flotation of spodumene with a soap collector, in contrast to feldspar and quartz. After cleaning, concentrates containing from 5.40 to 6.59 percent Li_2O were obtained, principally with the use of oleic acid; a mixture of spodumene and feldspar containing 4.98 percent Li_2O was separated by similar treatment.

(13) Engel, E. L., and Shelton, S. M., Tin ore from North Carolina, in Ore-testing studies, 1939-40: U. S. Bur. Mines Rept. Inv. 3564, p. 15, 1941.

Tin ore with feldspathic gangue, containing 1.06 percent tin, crushed to pass 10 mesh, was separated into four sand products in a laboratory hydraulic classifier. The sand products were treated on a laboratory concentration table, and yielded concentrates that assayed 68.81 percent tin, or 92.3 percent of the total tin.

(14) Gabriel, Alton, Slavin, Morris, and Carl, H. F., Minor constituents in spodumene: Econ. Geology, vol. 37, pp. 116-125, 1942.

Spectrographic analysis of spodumene from three areas in the belt showed the presence of minor amounts of Fe_2O_3, MnO, TiO_2, SnO_2, Ga_2O_3, Na_2O, and K_2O; one of the samples contained Rb_2O. On the basis of X-ray and petrographic studies, it is concluded that the impurities are probably isomorphous replacements in the crystal structure of the spodumene.

Production

Some production of cassiterite concentrates from the Carolinas is recorded [1/] for the years 1903-04, 1906-07, 1910,

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1/ Mineral Resources U. S. and Minerals Yearbook.
Pratt, J. H., The mining industry in North Carolina during 1911 and 1912: North Carolina Geol. Survey Econ. Paper 34, pp. 16, 73, 1914.

1912-13, 1918, 1930, and 1937, but specific tonnage is given in only a few instances. Graton [2] estimated that the total production of metallic tin to May 1905 probably did not exceed 50 short tons, a little more than half of which came from the Ross mine near Gaffney. Sloan [3] reported that the Ross mine alone had produced a total of approximately 130 tons of concentrates (about 85 tons of metallic tin) up to December 1, 1906, which seems excessive in view of Graton's estimate of 19 months earlier. But even if Sloan's figure for the Ross mine is correct, the recorded production of metallic tin from the entire belt is not more than 110 short tons. Dates and scales of operations subsequent to 1906 are known only approximately, but it seems unlikely that additional unrecorded production would raise the total above 300 tons.

GEOLOGY

Country rocks

Most of the tin-spodumene belt is underlain by interlayered hornblende-biotite gneiss and muscovite schist and gneiss, accompanied by very small quantities of chloritic gneiss and schist, quartz-tourmaline gneiss, augite-andesine gneiss, and enstatite-oligoclase gneiss. These foliated rocks were mapped by Keith and Sterrett [4] as parts of the Roan gneiss and Carolina gneiss, and regarded as pre-Cambrian, whereas the crystalline limestone and interlayered fine-grained muscovite schist and quartzite which crop out in a nearly continuous zone along the eastern side of the belt were regarded as Cambrian. The observations made during the present investigation indicate that, at least in the areas mapped in detail, the gneisses are strongly

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2/ Graton, L. C., A reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, pp. 9, 54, 1906.

3/ Sloan, Earle, A catalogue of the mineral localities of South Carolina: South Carolina Geol. Survey, ser. 4, Bull. 2, p. 92, 1908.

4/ Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Gaffney-Kings Mountain folio (No. 222) 1931.

metamorphosed parts of the marble-schist-quartzite sequence, and not older rocks. Neither sharp contacts nor the strike faults mapped by Keith and Sterrett were found to separate the two groups of rocks; there appears, rather, to be a gradational zone between them in which transitional types of rocks occur. The rocks strike generally northeast and dip steeply northwest except in the vicinity of Gaffney, where they dip southeast.

Large, extremely irregular bodies of granitic rock called the Whiteside granite by Keith,[5] occur in the belt and in the region to the west. The mineral composition of this rock, where adjacent to pegmatite bodies, is similar to that of the pegmatite, but simpler, consisting largely of microcline, quartz, and sodic plagioclase. In places the two rocks intergrade. Pegmatite bodies in the vicinity of Kings Mountain form a peripheral zone along the sinuate east side of a large body of the granitic rock (pl. 39). This areal relationship suggests that the pegmatite minerals that are also constituents of the granitic rock probably were derived from the granitic rock or from its source. The pegmatite minerals that are not constituents of the granitic rock may have had a different source.

All of the rocks, including the pegmatite bodies, described below, are cut by dikes of fine-grained diabase, similar to those that have been intruded into Triassic rocks farther east in the Piedmont. The diabase dikes are steeply dipping, tabular bodies, which range in thickness from a few inches to 35 feet, and trend N. 40°-50° W., but two dikes less than 1 foot thick were seen that are parallel to the bedding in weathered micaceous limestone.

Pegmatite

The tin- and spodumene-bearing pegmatite bodies are mostly tabular, of lenticular horizontal section, and of unknown verti-

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5/ Keith, Arthur, op. cit.

cal dimensions. The most regular in outline were emplaced in major joints that strike northwestward across the metamorphic rocks; few of these are more than 25 feet thick or 450 feet long. Other, more numerous, bodies lie parallel to the strike of interlayered country rocks. These are less regular in plan than those in the joints and are larger, attaining a maximum thickness of 395 feet and a maximum length of 3,250 feet. Of the hundreds of pegmatite bodies in the belt, most are less than 10 feet thick, and the smallest are lenslike aggregates of quartz and feldspars less than an inch in length.

The pegmatite of the Carolina belt differs notably from all that seen by the writer elsewhere in the Southern Appalachian region, except the tin-bearing pegmatite of Coosa County, Ala. The pegmatite in both areas consists largely of fine-grained albite and quartz, but the Alabama pegmatite is simpler in mineral composition than that of the Carolinas, and apparently contains no lithium minerals and very little coarse-grained microcline. The pegmatite of the Carolina belt is closely associated with much quartz-muscovite rock termed greisen, some of which contains cassiterite.

Minerals.--The dominant constituents of the pegmatite are fine-grained albite and quartz. The coarse oligoclase which characterizes much of the pegmatite in the Blue Ridge province occurs here only in very small quantity, and muscovite, though generally present, is too fine-grained and scarce to be of commercial value except as a possible minor byproduct. Microcline and spodumene, which are common but rarely dominant, are mostly medium- to coarse-grained. The crystals are characteristically fractured, and are veined with the fine-grained albite and quartz; a few of the smaller crystals of microcline are euhedral, but no euhedral crystal of spodumene was seen during the present study. The maximum observed dimension of microcline is 45 inches. The spodumene crystals are lath-shaped; the maximum

length observed is 38 inches, and the maximum thickness 10.5 inches.

Cassiterite occurs persistently enough to be characteristic, though in general it is not abundant. It is dark brown in color, and is conspicuous among the white and light-colored minerals of the pegmatite. The grains are mostly between 0.5 mm. and 2.0 cm. in maximum diameter. They are angular and fractured and, although they commonly show one or more crystal faces, only two complete crystals are known to have been found. Cassiterite can be confused with only two other pegmatite minerals, columbite-tantalite and ilmenite, but the three can easily be distinguished by their streak alone: that of the cassiterite is light tan to cream-colored, that of columbite-tantalite is chocolate brown, and that of ilmenite is black.

The spodumene offers probably greater commercial possibilities than the cassiterite, particularly if regarded as the chief product in a possible concentration procedure that would yield other pegmatite minerals as byproducts. The possible reserves of recoverable spodumene in two outstanding areas are considered on pages 267-269. Spodumene is distributed unevenly in the pegmatite bodies, but less so than cassiterite. Many of the finer-grained bodies consist predominantly of albite and quartz, and carry little spodumene, but many of the coarser-grained bodies may contain an average of 15 percent or more. Spectrographic analysis of the spodumene [6/] has shown the presence of eight minor impurities which are believed to be isomorphous constituents of the mineral. These are listed above in the annotated bibliography (p. 250).

A complete list, in alphabetical order, of the minerals that have been found in the pegmatite bodies during the present study is given on the following page. Minerals listed as hypogene

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6/ Gabriel, Alton; Slavin, Morris; and Carl, H. F., Minor constituents in spodumene: Econ. Geology, vol. 37, p. 119, 1942.

include those that were deposited by igneous emanations from a deep-seated source, together with small amounts of actinolite, hornblende, biotite, clinozoisite, and graphite derived from the wall rocks. The minerals listed as supergene were formed by weathering of the hypogene minerals. Hypogene minerals that apparently are not fairly well disseminated through the pegmatite are indicated by an asterisk.

Hypogene

Amblygonite†	Scarce.
Apatite	Scarce.
Beryl	Scarce, locally common; mostly resembles quartz.
Cassiterite	Scarce except in shoots.
*Chalcopyrite	Very scarce.
Columbite-tantalite	Scarce.
*Dufrenite	Very scarce.
*Dumortierite	Very scarce.
*Garnet	Scarce.
*Lithiophilite	Very scarce.
*A blue manganese phosphate	Very scarce.
Microcline	Common; locally abundant.
*Molybdenite	Very scarce.
Muscovite	Common; abundant in greisen.
Plagioclases:	
An_0 to An_5	Abundant.
*An_5 to An_{40}	Scarce.
*Pyrite	Scarce.
Pyroxenes:	
*Diopside	Very scarce.
Spodumene	Common; locally abundant.
*Pyrrhotite	Very scarce.
Quartz	Abundant.
*Rutile, tin-bearing	Found as float; very scarce.
*Sphalerite	Scarce.
*Titanite	Very scarce.
*Tourmaline	Scarce.

Supergene

Halloysite	In seams.
Kaolinite and hydrous mica	Common locally.
Purpurite	Very scarce.
Vivianite	Very scarce.
Fine-grained mixtures of hydrous ferric and calcium-ferric phosphates with hydrous iron and manganese oxides; colors olive green, yellow, brown, black	Common.

† Optical and qualitative chemical determinations indicate a composition near the montebrasite end of the amblygonite-montebrasite series.

Structural control of emplacement.--The pegmatite was emplaced in openings formed by minor rock movements that accompanied or followed the folding of the older rocks. The openings include joints that cross the layering (see pl. 40), openings that follow the layering (see pl. 39), and irregular openings (see pl. 41); those of the first two types are common, those of the last rather scarce.

In areas underlain by almost uniformly competent hornblende-biotite gneisses, pegmatite was emplaced in joints that cut at various angles across the strike of the rocks. One such area, which lies in the Beaverdam Creek drainage area, between Lincolnton and Kings Mountain, is shown in plate 40. The pegmatite bodies here are straight, tabular, and nearly uniform in thickness; some bend abruptly where prominent joints intersect. One body in this area is cut by a thick Triassic diabase dike, and an inclusion of pegmatite was found in the diabase. It seems probable that the diabase dikes were intruded into pre-pegmatite joints, however, for their prevailing trend, N. 40°-60° W., falls within the strike range of three sets of the joints.

In areas where country rocks of contrasting competence alternate in relatively thin layers, most of the pegmatite was emplaced parallel to the strike and dip of the layers. Such an area, immediately southwest of Kings Mountain, is shown in plate 39. The interlayered country rocks here are largely competent hornblende gneisses and incompetent muscovite schists.

Some of the pegmatite bodies on the property of the Ka-Mi-Tin Concentrating Co., 2 miles southeast of Lincolnton, are of the third type: they are extremely irregular in shape and attitude. The bodies prospected by power shovel in the western part of the area shown in plate 41 appear to have been emplaced in irregular fractures that commonly cut across the foliation of muscovite schist but are oriented at random.

Origin.--The minerals of the pegmatite bodies were deposited in the order given below. The order of deposition, which is the same throughout the belt, is also the order of increasing abundance with the exception of the minerals of the first stage and the sulfides of the seventh. There is little or no evidence on which to date some of the minerals, and these are not included in the sequence. The relative ages of the minerals listed are apparent from relative degrees of deformation, and from veining and replacement of earlier by later members. Quartz apparently was deposited during all stages but most abundantly in two.

Stage 1. Tourmaline, beryl, and apatite.
Stage 2. Cassiterite and columbite-tantalite.
Stage 3. Quartz (most of the greisen formed).
Stage 4. Spodumene.
Stage 5. Microcline.
Stage 6. Medium-grained albite (minor alteration of spodumene and microcline to muscovite).
Stage 7. Fine-grained albite and quartz (minor quantities of sulfides and apatite).

The minerals are believed to have been deposited by solutions, along channels that were reopened from time to time by intermittent rock movements. The inferred process of deposition may be outlined as follows:

The minerals of stages 1 and 2 developed in and adjacent to prominent joints and fissures forming deposits of three types: (a) Veins and lenticular masses of compact crystalline tourmaline in gneisses and schists; (b) lodes of disseminated tourmaline crystals in muscovite schist; (c) veins and lodes or disseminations of cassiterite, columbite-tantalite, and probably ilmenite, in muscovite schist, between layers of muscovite schist and hornblende gneiss, and in joints that cut obliquely across hornblende-biotite gneisses.

Many deposits of types a, b, and c were fractured and dislocated by wall-rock movements, and the new openings served as channels for the introduction of the quartz of stage 3, which veined the earlier minerals. Quartz also has partially replaced muscovite schist, into which it commonly grades. The muscovite

left by partial replacement has been coarsened by recrystallization, but remains oriented for the most part parallel to the unsilicified schist. It is in the resulting aggregate of quartz and muscovite, called greisen, that cassiterite of possible commercial grade occurs most commonly. At many places, however, quartz was deposited in schist that contained no earlier cassiterite, and greisen is not uncommonly barren of tin. Rarer and possibly later types of greisen that, in places, contain earlier cassiterite were formed (1) locally in joints in hornblende gneiss, with the muscovite possibly derived from alteration of earlier pegmatite minerals, and (2) as zoned open-space fillings 6 inches or less in width, conformable with muscovite schist and containing muscovite crystals oriented perpendicular to the walls.

Some of the early deposits formed during stages 1, 2, and 3 were not greatly disturbed by later rock movements, and they remained unchanged, or but little changed, in mineral composition. Conversely, the minerals of one or more of the early stages are lacking in pegmatite bodies developed by the deposition of later minerals in channels opened after the early deposits were formed. Most of the pegmatite bodies, however, contain minerals of each stage of deposition, indicating that many lines of weakness were persistent.

Not only quartz but other pegmatite minerals were deposited in fissures and joints, and partially replaced adjacent bodies of country rock as much as 400 feet thick. The paragenetic relations are the same in both environments: each pegmatite mineral that replaced wall rocks did so at the same time that it was being deposited in open joints and fissures. The later pegmatite minerals replaced greater volumes of the country rocks than did those deposited earlier, and are more abundant. Replacement of wall rock occurred most commonly where hornblende gneiss and muscovite schist are interbedded, the muscovite

schist being the more extensively replaced. Minerals that replaced wall rocks were less severely fractured by recurrent rock movements than those deposited in openings, and those in oblique joints somewhat less severely than those in fissures parallel to the bedding.

A relatively fine-grained aggregate of albite and quartz of stage 7 is by far the most abundant replacement product. A similar replacement of country rock by plagioclase has been described by C. S. Ross.[7/] Tourmaline, spodumene, microcline, and plagioclase as calcic as An_{40} also replaced the wall rocks. Replacement by these minerals, in various degrees, is abundantly exemplified in the belt. Spodumene and microcline, the coarsest-grained minerals, developed to greater size in open fissures, particularly those parallel to bedding, than in replaced wall rock.

From the order in which the pegmatite minerals were formed it is inferred that the composition of the solutions from which the minerals were deposited changed as the process went on but was comparatively simple at any given stage. The partial replacement of large bodies of country rock indicates that these solutions could not have been viscous; had they been so they could not so intimately have permeated the rocks. They are thought to have been aqueous.

TIN DEPOSITS

Deposits with greisen gangue

The cassiterite-bearing bodies of greisen, which are the simplest of the ore bodies in mineral composition, are believed to be relatively undisturbed relics of the early pegmatite

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7/ Ross, C. S., Origin of the copper deposits of the Ducktown type in the southern Appalachian region: U. S. Geol. Survey Prof. Paper 179, pp. 24-25, 71, 1935.

stages. The maximum known thickness of the tin-bearing greisen bodies is 3.5 feet, but the average thickness of 35 of them is only 1 foot. No deposit of this type is exposed for its full length, but apparently none is more than 100 feet long and most of them are less than 50 feet long. The few ore bodies that have been prospected to depths greater than their observed lengths along the surface seem to be shootlike in form, but little is known about their dip or pitch lengths.

Deposits with feldspathic gangue

Tin deposits in which the gangue is dominantly feldspathic pegmatite are less numerous than the greisen deposits, but they generally are larger; the largest dimensions measured or reliably reported are: Thickness, 9 feet; strike length, 275 feet; pitch length, more than 200 feet. Three of the larger deposits of this type, the Jones, Faires, and Ross,[8/] have a well-defined pitch, which is probably true of most of the feldspathic as well as of the greisen deposits.

The cassiterite of these deposits apparently was emplaced along lines of weakness sufficiently pronounced to be reopened by subsequent movements of the wall rocks, with accompanying abundant deposition of later pegmatite minerals. Some of the tin deposits remain relatively intact, in and along the margins of pegmatite bodies thus enlarged, but others were so disrupted by the recurrent movements that only small and apparently disconnected parts of them are found in the feldspathic bodies. By a decrease in the abundance of cassiterite, these deposits grade into relatively barren feldspathic pegmatite that contains perhaps 1 to 25 grains of cassiterite in each cubic foot.

8/ See references cited in table 18 for descriptions of these mines when in operation prior to 1907.

Quantity and grade of ore

During the course of the present investigation, 55 tin deposits, most of them poorly exposed, were examined (pl. 38). The locations of 37 others, including some mentioned in published accounts of early mining operations, were established only by float ore; 32 that were reported could not be found. With few exceptions, the 92 known deposits are too widely separated to permit the mining of more than one in a single operation. The maximum thicknesses of deposits in which this dimension could be measured were from 1½ to 6 inches for 21 deposits, from 7 inches to 2 feet for 16 deposits, and from 3 to 4 feet for 4 deposits. Sloan [9] states that the Ross deposit was 9 feet thick near the surface prior to its removal by mining.

The cassiterite content of the ore bodies is very uneven. Assays and mill recoveries have shown that in adjacent deposits, or even within a single deposit, the metallic tin content ranges from a trace to more than 6 percent. Field estimates as high as 10 percent have been made for small parts of ore bodies. There are no geologic indications that the cassiterite content will change materially in grade or mode of occurrence with depth, and this is true also of the associated nonmetallic pegmatite minerals.

Accurate data from which to derive an estimate of ore reserves are lacking. On the basis of the approximate dimensions and general grade of the 55 ore bodies examined, and published information on previous mining (see references listed in table 18), the gross tin content of all the deposits in the area may be as much as 10 tons of metallic tin per foot of depth; this includes at least 7 of the larger deposits that have been mined to depths as great as 175 feet. Most of the deposits are

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9/ Sloan, Earle, op. cit., p. 39.

less than a foot thick, however, and are not minable under ordinary conditions.

Only 18 of the deposits are known to be 1 foot or more thick, and for these the limit of reasonably inexpensive mining is the depth of partly weathered rock above the level of ground water, which is about 50 feet. Seven of these deposits, as mentioned above, have been mined to or below this depth, and one (the Swamp shaft ore body of the Ka-Mi-Tin Concentrating Co., which was under water during the present survey) is in low, marshy ground. The remaining 10 bodies of ore 1 foot or more thick have an average grade of possibly 1.5 percent tin; an average thickness of 3 feet and an average length of 100 feet are assumed, giving a calculated reserve of 12,500 tons of ore, containing 188 tons of metallic tin, to a depth of 50 feet, an average of 0.375 ton of tin per foot of depth in each deposit. The 8 deposits of minable widths that have been mined to or below water level may contain ore of equal or even higher tin content, but the costs of mining would necessarily be much higher.

Placer deposits

The few known placer tin deposits in the belt occur in narrow valleys, near deposits in place; but most of them are less than 10 feet thick and contain only a negligible tonnage of cassiterite. Nothing is known regarding the possible occurrence of cassiterite in larger alluvial deposits farther downstream. Three of the most promising of the placers have been worked on a small scale.

The best known placer deposit is that at the Ross mine (locality 60 on pl. 38, and pl. 42), which yielded an unknown part of the mine's production of 130 tons of concentrates.[10/] Of the original placer deposit, about 2,500 tons of cassiterite-

10/ Sloan, Earle, op. cit., p. 92.

bearing alluvium remains in an area of 25,000 square feet. The remainder of the deposit is probably of low grade. The margin of the deposit is shown in plate 42, which also shows the locations of the original open cut and 121-foot shaft, as well as more recent prospect openings.

A placer deposit, having a surface area of 60,000 square feet [11] adjacent to the Jones mine (locality 23, pl. 38) was prospected in 1903-04, but the results are unknown. Keith [12] states that the Blue Ridge Tin Corporation produced several thousand pounds of concentrates from part of an alluvial area of about 50,000 square feet in the narrow valley immediately south of locality 50, plates 38 and 39.

The three known placers, together with similar small bodies yet to be discovered, might add as much as 100 tons of metallic tin to the reserves. A little additional placer tin might be recovered from the tin-bearing soils, mostly less than 1 foot thick, which cover the weathered bedrock for distances rarely exceeding 300 feet down slope from outcrops of the tin deposits. These shallow soils, which could be removed by scraper, may contain about 50 tons of metallic tin. Very few of the deposits in place, however, are weathered sufficiently to be handled by scrapers.

Summary of deposits

The locations of all deposits examined or reported are shown in plate 38, and available information bearing on geologic and economic features are listed in table 18. Underground workings were not accessible at the time of the survey. A few of these have been described in earlier reports, and references to the descriptions are listed in the table.

11/ Pratt, J. H., and Sterrett, D. B., The tin deposits of the Carolinas: North Carolina Geol. Survey Bull. 19, p. 29, 1904.

12/ Keith, Arthur, and Sterrett, D. B., Tin resources of the Kings Mountain district, N. C. and S. C.: U. S. Geol. Survey Bull. 660, p. 141, 1917.

Atlas prospect shaft.--Early in 1941, at the completion of the present study of the tin deposits, the Atlas Collapsible Tube Co., of Chicago, began prospecting at the old Faires mine near the southern limit of the town of Kings Mountain. A shaft about 30 feet deep was sunk 125 feet northeast of the Faires shaft without encouraging results. Two churn-drill holes approximately 40 feet apart were then drilled about 200 feet N. 15° W. of the Faires shaft. Hole No. 1 was drilled to a depth of 122 feet, and hole No. 2 to a depth of 144 feet. Showings of tin ore were reported from each hole, but No. 2, in which the showings were said to be best at depths of 59, 89 to 104, and 144 feet, was considered the better; a shaft was then sunk adjacent to hole No. 2. The shaft had reached a depth of 125 feet in April 1942, when the management permitted an examination to be made.

The walls of the shaft were boarded up. Crosscuts had been driven from the bottom for 30 feet northwest and 12 feet southeast. Two pegmatite bodies and two layers of greisen, conformable with the foliation in muscovite schist, were exposed in the crosscuts, as shown in figure 28. The larger of the pegmatite bodies is 7 feet thick, and was exposed at the base of the shaft; it is said to have lensed out upward at a depth of 95 feet. The section of this body exposed in the northeast wall of the shaft shows the relative ages of some of the commoner pegmatite minerals. Relatively fine-grained albite and quartz, comprising a lenticular core about 2 feet thick, have invaded a distinctly earlier body composed largely of coarse-grained microcline with some spodumene, quartz, and cassiterite.

The cassiterite was seen only in the microcline-rich rock in the southwest wall of the shaft where the albitic rock has permeated the older mass irregularly, and is not confined to a core. It was obvious that the cassiterite-bearing rock at this point is of commercial grade, averaging possibly as much as 2 percent

of tin, but no cassiterite was seen along the strike in the opposite wall. In order to determine whether or not all of the microcline-rich rock can be regarded as tin ore, a transverse channel sample was taken from the northwest side of the body, in the northeast face.

The pegmatite body exposed in the southeast crosscut is 2 to 4 feet thick, has a layered structure, and consists of fine-grained albite and quartz; a little coarse-grained microcline

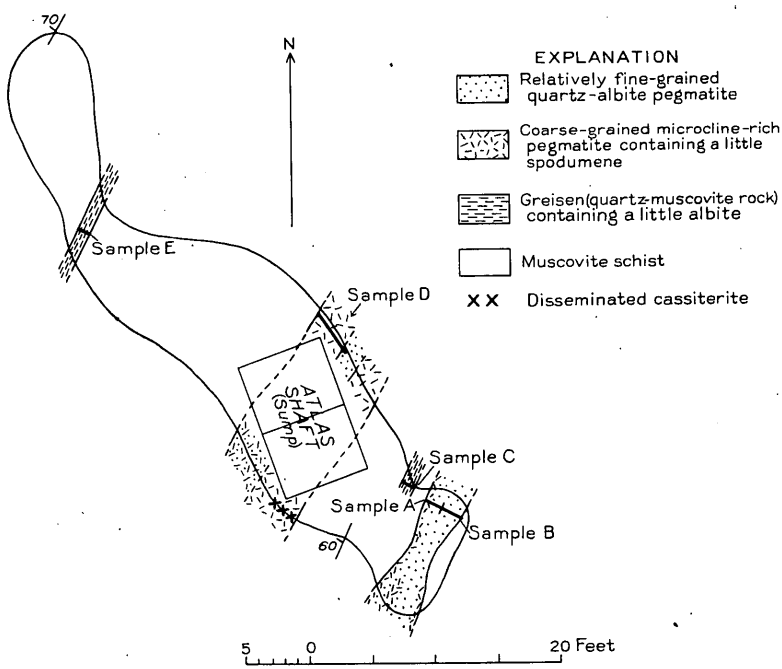

Figure 28.--Plan of crosscut and rocks exposed at base of Atlas shaft, April 1942.

occurs largely, but not entirely, adjacent to the enclosing schist. No cassiterite was visible in this body, but a transverse channel sample was taken from the northwest 14 inches of the body, and another from the southeast 18 inches.

Each of the greisen layers exposed, one in the southeast crosscut, the other in the northwest, is 12 inches thick. Each layer was sampled.

The five samples, assayed by J. G. Fairchild in the chemical laboratory of the Geological Survey, showed less than 0.03 percent of metallic tin in each. It is apparent, therefore, that the only ore of economic grade found in crosscutting four bodies of possible tin-bearing rock, which have an aggregate thickness of 11 feet 8 inches, is in the larger pegmatite, and is exposed only in the southwest wall of the shaft. The continuity of the ore to the southwest of the shaft can be determined only by drifting in that direction.

SPODUMENE RESERVES

The tin-spodumene belt contains an enormous reserve of spodumene, but a steady production in large quantities can be attained only by mining and milling comparatively rich pegmatite that may contain from 10 to 50 percent of spodumene. This might be feasible if a concentration procedure were developed that would yield spodumene as the chief but not the only product. Possible byproduct minerals, for which there are ready markets, include cassiterite, columbite-tantalite, beryl, fine-grained muscovite, feldspars, and possibly amblygonite. All of these except the feldspars are minor constituents where spodumene is most abundant.

In laboratory tests that showed the possibility of making a good separation of spodumene, Norman and Gieseke [13] used rock from the tin-spodumene belt that contained from 33 to 50 percent spodumene. Hess [14] states that hand-cobbed ore mined 1¼ miles southwest of Kings Mountain contained more than 50 percent spodumene. He estimates [15] that the pegmatite bodies of the entire belt may contain an average of 15 percent spodumene. The available information concerning grade is derived, however, from ore

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13/ Norman, James, and Gieseke, E. W., Beneficiation of spodumene rock by froth flotation: Am. Inst. Min. Met. Eng. Tech. Pub. 1161, p. 2, 1940.

14/ Hess, F. L., The spodumene pegmatites of North Carolina: Econ. Geology, vol. 35, p. 965, 1940.

15/ Idem.

that has been taken only from some of the richest outcrops; pegmatite bodies that contain only small, sporadic crystals have apparently escaped general notice. Because of the high proportion of fine-grained bodies that consist largely of albite and quartz, it is neither possible nor practicable to estimate the total amount of spodumene in the belt.

The most favorable showing of spodumene is exposed in a quarry 100 feet long, 12 feet wide, and 35 feet in maximum depth, located 1¼ miles southwest of Kings Mountain. The opening has been made in the east side of a pegmatite body 85 feet thick at this point, and at least 1,450 feet long, but the comparatively rich part exposed in the quarry averages only about 8 feet in thickness. The spodumene crystals here are among the largest in the belt; the maximum length observed was 38 inches. It is reasonable to expect a small quantity of hand-cobbed ore containing as much as 50 percent of spodumene from this quarry, but the large quantity of low-grade rock on the dump shows that only the richest part of the rock exposed is of such grade. The rest of the pegmatite body also contains spodumene, but the average grade is considerably lower than that of the rock in the quarry, and few of the crystals exceed 3 inches in length.

Some of the pegmatite bodies richest in spodumene occur in the two areas shown in plates 39 and 40. Although they constitute only a small portion of the belt, these two areas contain more than 700 pegmatite bodies 1 foot or more thick. The total number in the belt, therefore, must be very large. It is possible to make a rough estimate of the quantity of spodumene ore in these areas, although little is known about the average spodumene content of the pegmatite that could be applied to large tonnages. Comparatively small parts of bodies that may contain as much as 50 percent of spodumene are included because their limits are unknown, and separate estimates cannot be made.

The Beaverdam Creek area, shown in plate 40, contains 388 pegmatite bodies 1 foot or more thick. Spodumene was identified in 245, and about half of these may contain from 10 to 25 percent of spodumene, but probably not more than one-fourth are large enough to be workable. About 60 bodies, therefore, having an average thickness of about 10 feet and an average length of 250 feet, are estimated to contain rock of possible commercial grade. Assuming that not more than half of the material in these bodies would be rich enough to mill, and that this part would yield at least 15 percent of spodumene, it is estimated that the Beaverdam Creek area contains something on the order of 625,000 tons of possible ore, containing about 93,750 tons of recoverable spodumene, to a depth of 100 feet.

The area southwest of Kings Mountain, shown in plate 39, contains 376 pegmatite bodies 1 foot or more thick. Spodumene was identified in 256; it is safe to assume that at least half of these, or 128, include rock that contains from 10 to 25 percent of spodumene, and are thick enough to be quarried. The bodies in this area have a wider range of thickness and length than those in the Beaverdam Creek area, but spodumene is less evenly distributed, so that greater allowance must be made for rock that would not be milled, perhaps not even quarried. It is estimated that the average thickness of the 128 bodies is 35 feet and the average length 540 feet; probably not more than one-fifth of the rock they contain would be workable, and this entire amount probably contains at least 15 percent of spodumene. Using these figures, it is estimated that this sector of the belt contains no less than 3,700,000 tons of possible ore, containing about 555,000 tons of recoverable spodumene, to a depth of 100 feet.

The combined estimate for the two areas is a minimum of nearly 650,000 tons of spodumene in rock that may be minable to

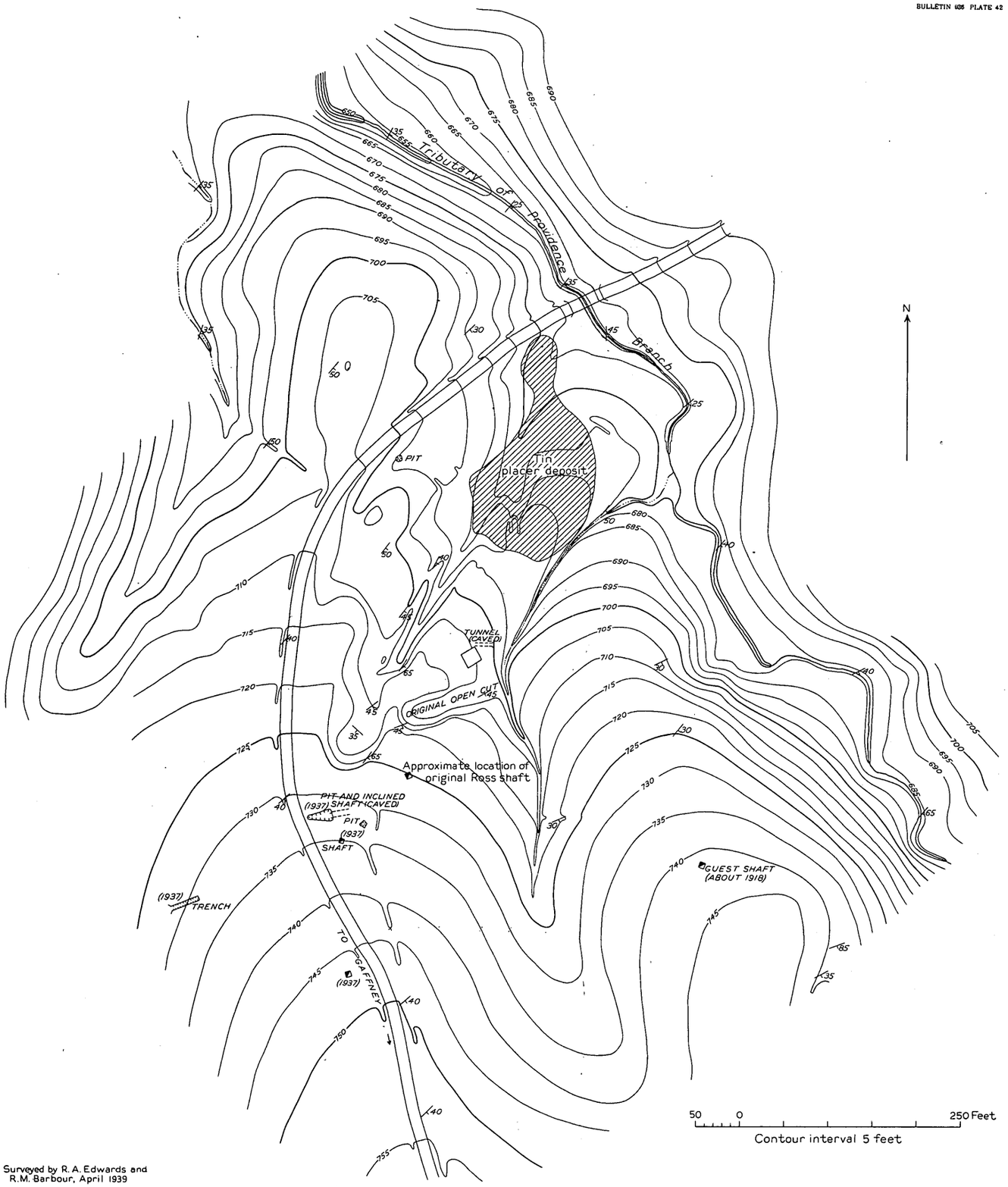
a depth of 100 feet. Boyd [16] gives the following analysis of the spodumene obtained from a hand-sorted sample crushed to minus one-half inch, from which fragments containing visible impurities were rejected:

	Percent		Percent
SiO_2	63.84	K_2O	None
Al_2O_3	28.61	Na_2O	None
Fe_2O_3	.19	Li_2O	7.26
CaO	.04	Ignition loss	.16
MgO	Trace		

It has been found [17] that the amounts of the minor constituents, particularly Fe_2O_3, vary considerably even in a single pegmatite body. Assuming an average of 7 percent LiO_2, the possibly recoverable spodumene estimated above would contain about 45,500 tons of lithia, or more than 20,000 tons of metallic lithium. The two areas to which this estimate applies have a combined length of only 6½ miles out of a total of 24½ miles for the belt. Further, the estimate applies only to the very large quantities of spodumene rock that might be minable for a composite mineral output, rather than to the relatively small bodies of rock that contain from 30 to 50 percent of spodumene.

16/ Boyd, J. E., Jr., Pyrometric properties of spodumene-feldspar mixtures: Am. Ceramic Soc. Jour., vol. 21, p. 386, 1938.

17/ Gabriel, Alton; Slavin, Morris; and Carl, H. F., op. cit., pp. 119-121, 124.



Surveyed by R. A. Edwards and R. M. Barbour, April 1939

PLAN OF THE ROSS MINE AND VICINITY

CIRC. 225

Spectroscope Sensitivity & Or Resolution

Cb = .01 %
Ta = .10 or .08
Ec = .0001 %
Sm = .001

GEOLOGICAL SURVEY CIRCULAR 225

GEOCHEMICAL ASSOCIATION OF NIOBIUM (COLUMBIUM) AND TITANIUM AND ITS GEOLOGICAL AND ECONOMIC SIGNIFICANCE

By Michael Fleischer, K. J. Murata, Janet D. Fletcher, and Perry F. Narten

UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

GEOLOGICAL SURVEY CIRCULAR 225

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This report concerns work done on behalf of the U.S. Atomic Energy Commission and is published with the permission of the Commission.

Washington, D. C., 1952

Free on application to the Geological Survey, Washington 25, D. C.

GEOCHEMICAL ASSOCIATION OF NIOBIUM (COLUMBIUM) AND TITANIUM AND ITS GEOLOGICAL AND ECONOMIC SIGNIFICANCE

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ABSTRACT

Niobium in rocks occurs in highest concentrations in granitic pegmatites and in alkalic rocks such as the nepheline syenites. It occurs commonly as a substituent in titanium minerals. Weathering of alkalic rocks produces bauxite enriched in niobium. Analyses show bauxite from Arkansas to contain an average of 0.05 percent Nb. The niobium present in the Arkansas bauxite processed annually is equal in amount to about 80 percent of that imported annually by the United States. Fractionation of black sand from Arkansas bauxite shows the niobium to be concentrated chiefly in an ilmenite fraction containing more than 40 percent TiO_2 and as much as 0.86 percent Nb.

Analyses of titanium minerals from many sources show the presence of niobium, the amount present varying with the type of rock in which the minerals occur. Minerals from alkalic rocks and from granitic pegmatites are highest in niobium content.

Metallurgical research is needed, especially on the possibility of recovering niobium and titanium from chlorination processes.

INTRODUCTION

Niobium (columbium) has recently become important in the manufacture of certain high-temperature and non-creep steels. The United States imported more than 1-1/2 million pounds of niobium ore (concentrates) in 1949 (Clark, 1951);[1] domestic production was very small. The world production has come from granitic pegmatites and as a byproduct of the recovery of cassiterite from placers derived from granitic rocks.

Early in 1951 the Geological Survey undertook a search for new sources of niobium. Fortunately the general pattern of the geochemical behavior of niobium was fairly well known from an earlier summary of the literature (Fleischer and Harder, 1945) and from the comprehensive researches of Rankama (1948). From these it was possible to select for further study several types of material in which niobium might be present in concentrations sufficient to make them of interest as source materials.

Those selected as the most promising types of material were (1) alkalic rocks, especially nepheline syenites; (2) bauxites derived from alkalic rocks; (3) titanium minerals and ores; (4) zirconium minerals and ores; (5) tungsten minerals and ores; and (6) tin minerals and ores. The present report is a preliminary account of work on the first three. Niobium has been found in concentrations sufficiently high to justify research on the metallurgical processes for its separation and recovery. The search for new sources of niobium will be continued, and it is hoped that this report will stimulate others to begin the required metallurgical research.

[1]See Literature cited

ACKNOWLEDGMENTS

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Samples for analysis were contributed by the following companies, who kindly granted permission to publish the results obtained. Alcoa Mining Co., American Cyanamid Co., Dulin Bauxite Co., Consolidated Chemical Industries, Dulin Bauxite Co., E. I. du Pont de Nemours Co., The Glidden Co., National Lead Co., New Jersey Zinc Co., and Ventures, Ltd.

GENERAL GEOCHEMICAL CONSIDERATIONS

Niobium is a chemical element with atomic number 41 and atomic weight 92.91. It belongs to the fifth group of the periodic table and is quinquevalent in most of its compounds. Niobium is a rare element; Rankama (1948, pp. 48-52) estimates its abundance in igneous rocks to be 0.0024 percent, which would make it about thirty-first in abundance of the elements.

The empirical ionic radius of niobium is given as 0.69A. (Ahrens, 1952), not very different from those of magnesium (0.66A.) and ferrous iron (0.74A.). The valence of niobium, however, is so much higher that one would expect that magnesium and iron minerals formed in the early stages of magmatic crystallization would not contain much niobium. This expectation has been verified experimentally. As crystallization of igneous rocks proceeds, niobium is perferentially concentrated in the residual magmas as shown by Goldschmidt (1937) and by Rankama (1948). According to Rankama, the igneous rocks of highest niobium content are the granites (0.0021 percent), the syenites (0.0035 percent), and the nepheline syenites (0.031 percent). Of all igneous rocks, therefore, the nepheline syenites and similar alkalic rocks contain more than 10 times the concentration of other rocks and appear to be the most promising for further study.

Goldschmidt (1937, p. 667) points out that niobium would be expected, considering its ionic potential, to be concentrated during weathering processes; he states that for bauxite the factor of concentration is 4 to 5 as compared with the parent rock. Because the nepheline syenites are rocks high in niobium, bauxites derived from them should be particularly rich in niobium. This has now been tested and verified in the laboratory of the Geological Survey and a summary of the results on Arkansas bauxites has been published in a recent paper (Gordon and Murata, 1952). The study is being pursued further, particularly to learn the mode of occurrence of the niobium and its distribution in the bauxite district and among the minerals of the bauxite.

One would expect that niobium would occur as a substituent for elements of high valence having ionic radii close to 0.60A. These include quinquevalent Ta (0.68A.), quadrivalent Ti (0.68A.), Zr (0.79A.), Sn (0.71A.), and Mo (0.62A.), and sexivalent W (0.62A.). This is confirmed by experimental data except for molybdenum. The very close association of niobium and tantalum is well known. Rankama (1948, pp. 48-52) points out that these elements are separable in nature and that the Nb:Ta ratio, which averages 11.4, is very much higher (384) in nepheline syenites. The association of niobium with titanium has been shown by the work of Hevesy, Alexander, and Würstlin (1929), Kunitz (1936), Borowsky and Blochin (1937), Panteleleev (1938), and Rankama (1948). The niobium content of titanium minerals, with particular attention to their geological environment, is also under investigation in the Geological Survey laboratories. A summary of the results up to now, including data from the literature, is given below. Studies of the association of niobium with tungsten, tin, zirconium, and molybdenum will be reported later.

METHOD OF SPECTROGRAPHIC ANALYSIS

The spectrographic analyses were made under the following conditions:

Excitation: 220-volt ballasted d-c arc, run at 15.5 a. Arc gap maintained at 3.5 mm throughout the burning period. Arc image focussed on the slit at 5.5 magnification, and light from the central 2 mm part allowed to enter the spectrograph.

Spectrograph: Wadsworth-mounting type of grating spectrograph with dispersion of 5A/mm in the first order.

Wavelength range covered: 2,230 - 4,730A in the first order. Such a wide range is unnecessary for analyses solely for Nb, but was recorded so that the spectrograms would be available for future study of other elements.

Electrodes: High-purity graphite rods, 1/4 in. diameter, with thin-walled cavity as described by Myers (1951); used as the anode.

Plate: Eastman III-0, developed at 20°C for 5 min in DK-50 developer.

Plate calibration: Method of Dieke and Crosswhite (1943). Iron lines present in spectra of a quartz-microcline mixture containing 1 percent Fe_2O_3 (matrix of comparison standards) were used.

Microphotometer: Projection comparator-microphotometer employing a scanning slit at the plate.

Nb lines used: 3163.40 and 3194.98A. Limit of detection, 0.01 percent in the samples as analyzed.

Analytical curves were established by means of a set of standards containing known concentrations of Nb_2O_5 and Ta_2O_5 (high-purity oxides) in a matrix consisting of 60 parts of quartz, 40 parts of microcline, and 1 part of Fe_2O_3, 25-mg portions being arced to

completion. The standards were made by successive dilutions to contain 1.00, 0.464, 0.215, 0.100, 0.0464, 0.0215 ..... 0.00100 percent Nb and Ta. No internal standard was used. The quartz-feldspar-iron oxide matrix will hereafter be referred to as the pegmatite base.

All rocks and minerals were first crushed, quartered, and ground in agate mortars to pass 150-mesh silk bolting cloth. Bauxites and clays were then ignited at 900° C and the loss in weight noted so that the final percentage of Nb could be calculated to the original, unignited state.

In order to analyze materials of greatly different chemical composition by means of the pegmatite-base standards, the samples were further treated in such a way as to make their composition more nearly that of the standards. Igneous rocks were mixed with one-half their weight of pure quartz. All other materials were mixed with an equal weight of a powder composed of 95 percent quartz and 5 percent Na_2CO_3.

The prepared samples were then analyzed by arcing to completion duplicate 25-mg portions. All samples showing 0.05 percent or more of Nb were next diluted with sufficient pegmatite base so that their reanalysis would be done at a concentration level of about 0.015 percent Nb. This practice resulted in greater accuracy for samples high in Nb because these (in the diluted state) closely approached the comparison standards in composition. As a test of the reproducibility of the method, a number of samples were analyzed in duplicate on several plates on different days. Considering the mean of the duplicate on each plate as a determination, the results were within ± 10 percent of the average of all determinations.

To date, only a few samples have been analyzed chemically, and we are indebted to J. I. Dinnin and M. K. Carron, of the Geological Survey, for the chemical results tabulated below.

	Percent Nb		
	Spectrographic		Chemical
Bauxite----------	0.053	Av -99	0.05
Bauxite----------	.050		.03
Brookite----------	2.4		2.7
Wolframite--------	1.3		1.2
Lepidolite---------	1.1		1.2
	4.903		5.18

Av 1.03

EXPERIMENTAL RESULTS

Niobium in igneous rocks

The average content of niobium in various types of igneous rocks was determined by Rankama (1948) by the analysis of 78 samples with the following results:

	Percent Nb (average)
Anorthosites and dunites----------	0.00003
Diorites----------	.0004
Eclogites----------	.0004
Basic alkalic rocks----------	.0014
Ultrabasic rocks----------	.0016
Gabbros----------	.0019
Granites----------	.0021
Syenites----------	.0035
Nepheline syenites----------	.031

Our studies have confirmed the relatively high niobium content of nepheline syenites and related rocks and have shown that high niobium content is particularly characteristic of those alkalic rocks with which are associated the remarkable masses of crystalline $CaCO_3$ generally referred to as "carbonatites." As further study of these rocks, particularly of the mode of occurrence of the niobium in them, is under way, we shall reserve detailed discussion and merely present the data available on all rocks that have been reported to contain as much as 0.01 percent Nb. These data are assembled in table 1. Nearly all the 52 rocks listed are nepheline syenites or related rocks, with only a few rocks of granitic composition and a few mafic rocks that are associated with alkalic rocks. No quantitative data are yet available on the distribution of niobium among the minerals of these rocks, although it is known that the niobium is largely concentrated in such titanium minerals as rutile, ilmenite, perovskite, and sphene. Analyses of these minerals separated from the above-mentioned or from similar rocks are listed in table 8 and are discussed below under the heading "Niobium content of titanium minerals." Part of the niobium in some of these rocks is present in zirconium minerals such as zircon, eudialyte, and catapleiite, and part is in some rocks as the niobium minerals pyrochlore (alkalic rocks) and columbite or microlite (granitic rocks).

Niobium in bauxites

We have extended the work of Gordon and Murata (1952), whose analyses of 14 bauxites and bauxitic clays from Arkansas showed a minimum content of 0.02 percent Nb, a maximum content of 0.1 percent Nb, and an average content of 0.05 percent Nb. Table 2 lists these analyses and those of 32 additional samples which confirm the earlier results. Further work is in progress to determine how the niobium content varies in different parts and types of bauxite deposits in Arkansas and to determine the distribution of niobium among the minerals of the bauxite.

Analyses have also been made by the Geological Survey of many samples of bauxite derived from rocks other than alkalic rocks, including material derived from basaltic rocks, gneisses, and limestones. These samples have much lower contents of niobium; none was found that contained as much as 0.01 percent Nb. The samples include 5 lateritic bauxites from Oregon, collected by J. W. Hosterman; 28 high-alumina clays from Idaho and Washington, collected by I. G. Sohn and J. W. Hosterman; 3 bauxites from Surinam, Dutch Guiana, kindly furnished by Aluminum Co. of America and American Cyanamid Co.; and 1 bauxite from Berbice, British Guiana, kindly furnished by American Cyanamid Co. Rankama (1948) reports 0.004 percent Nb in bauxites from Melegesbanya, near Gant, Hungary, and from Rock Run, Ala. It is of interest to note (table 3) that samples of red mud from treatment of Surinam and Jamaica bauxites both contained 0.02 percent Nb, which suggests that these bauxites contain some thousandths of a percent of Nb.

We hope to analyze bauxites which are from localities, other than Arkansas, where the bauxite

Table 1.--Niobium content of rocks reported to contain 0.01 percent or more Nb

	Locality	Number of samples	Percent Nb	Type of rock	Collector	Analyst
1	Arkansas: Pulaski and Saline Counties.	9	0.016-0.035	Nepheline syenite	M. Gordon, R. P. Bryson.	K. J. Murata, H. J. Rose, Jr.
2	Arkansas, Saline County	1	.04	Tinguaite dike	W. T. Holser	K. J. Murata.
3	Arkansas, Magnet Cove	5	.02-.06	Alkalic rocks	W. T. Pecora	K. J. Murata, H. J. Rose, Jr.
4	Arkansas, Potash Sulfur Springs.	6	.05, .15, .27	do	W. T. Pecora, E. Ingerson.	J. D. Fletcher, K. J. Murata.
			1.6, 2.7, 3.0	Altered alkalic rocks		
5	Colorado, Iron Hill	11	.0X	Alkalic rocks	V. R. Wilmarth	J. D. Fletcher.
6	Idaho, Lemhi County	2	.01, .03	Granite pegmatite	W. A. Roberts	H. J. Rose, Jr.
7	New Hampshire, Bartlett	1	.02	Granite	W. T. Holser	K. J. Murata.
8	New Jersey, Beemerville	1	.01	Nepheline syenite	do	Do.
9	New Mexico, Wind Mountains	1	.02	do	do	Do.
10	do	1	.34	Eudialyte syenite	do	Do.
11	New Mexico, Black Mountains	1	.03	Nepheline syenite	do	Do.
12	New Mexico, Jemez Mountains	2	.01	Rhyolites	C. S. Ross	Do.
13	Texas, Sierra Diablo	4	.05-.2	Alkalic rocks	A. Slaughter	J. C. Rabbitt.
14	Greenland, Julienahaab dist.	2	[a].32, .21	Nepheline syenite		Ussing (1912).
15	Sweden, Gellaberg, Skåne	1	.017	Feldspar basalt		Rankama (1948).
16	Germany, Hammer	1	.02	Phonolite		Do.
17	Portugal, Serrade Monchique	1	.04	Nepheline syenite		Rankama (1948).
18	U.S.S.R., Mariupol dist.	7	.02-.08	do		Morozewicz (1930).
19	U.S.S.R., Kola Peninsula	1	.11	Titanomagnetite olivinite.		Rankama (1948).

[a]The accuracy of these old chemical analyses is questionable.

Table 2.--Niobium content of Arkansas bauxite

Sample no.	Percent Nb	Collector	Analyst
1	0.02	M. Gordon	K. J. Murata.
2	.04	do	Do.
3	.050	do	Do.
4	.06	do	Do.
5	.03	do	Do.
6	.02	do	Do.
7	.04	do	Do.
8	.053	do	Do.
9	.07	do	Do.
10	.04	do	Do.
11	.1	do	Do.
12	.02	W. R. Griffitts	Do.
13	.02	R. P. Bryson	Do.
14	.08	J. I. Tracey, Jr.	Do.
15	.085	M. Gordon	Do.
16	.028	do	Do.
17	.048	do	Do.
18	.033	do	Do.
19	.04	Alcoa, Hurricane Creek	Do.
20	.051	Reynolds Metal Co., Hurricane Creek.	J. D. Fletcher.
21	.047		Do.
22	.045		Do.
23	.051		Do.
24	.051		Do.
25	.049		Do.
26	.05		K. J. Murata.
27	.055	R. P. Bryson	H. J. Rose and E. H Hufschmidt.
28	.036	do	Do.
29	.03	do	Do.
30	.03	do	Do.
31	.04	do	Do.
32	.082	do	Do.
33	.050	do	Do.
34	.03	do	Do.
35	.04	do	Do.
36	.02	do	Do.
37	.02	do	Do.
38	.02	do	Do.
39	.034	do	Do.
40	.043	do	Do.
41	.054	do	Do.
42	.057	do	H. J. Rose and E. H Hufschmidt.
43	.057	do	Do.
44	.034	do	Do.
45	.067	do	Do.
46	.050	do	Do.
Average, 46 samples			0.045
Average, 39 individual samples			.044
Average, 7 composite samples (nos. 20-25, 46)			.049

Descriptions of samples:

1. Dark reddish-brown to black bauxite pebbles filling channels in the lower bauxite bed in the Fletcher mine of Reynolds Mining Corp. in the W½SE¼SW¼ sec. 11, T. 2 S., R. 14 W., Saline County.
2. Oxidized ferruginous granitic-textured bauxite from a weathered outcrop in the Pruden mine, Alcoa Mining Co., NE¼SW¼ sec. 16, T. 2 S., R. 14 W., Saline County.
3. Red bauxite with black pisolites ("birds-eye ore") from mining face in the west part of the Section 16 mine, Alcoa Mining Co., SE¼SW¼ sec. 16, T. 2 S., R. 14 W., Saline County.
4. Granitic-textured bauxite ("sponge ore") block from along company road in Middle Maud mine, Alcoa Mining Co., in SW¼SE¼ sec. 22, T. 2 S., R. 14 W., Saline County.
5. Poorly pisolitic bauxite containing fine siderite, from U. S. Bur. Mines drill hole 3-019, depth 267 feet, South Ironton deposit, W.A. Dreher property, in the NW¼SE¼ sec. 14, T. 1 S., R. 12 W., near Ironton, Pulaski County.

Descriptions of samples, table 2--Continued

6. Pisolitic bauxite hardcap with fluid pisolites from U. S. Bur. Mines drill hole 6-127B, depth 278 feet, Bates deposit, in the NW¼NE¼ sec. 21, T. 1 S., R. 12 W., Pulaski County.
7. Pisolitic bauxite cut by a vein of crystalline siderite in U. S. Bur. Mines drill hole 16-048, depth 455.2 feet, in the East Bauxite deposit, International Paper Co. property, in the SE¼ sec. 31, T. 2 S., R. 13 W., Saline County.
8. Poorly pisolitic bauxite containing siderite and chlorite, from U. S. Bur. Mines drill hole 16-052, depth 473.0 to 473.1 feet, East Bauxite deposit, International Paper Co. property, SE¼ sec. 31, T. 2 S., R. 14 W., Saline County.
9. Poorly pisolitic siliceous bauxite from U. S. Bur. Mines drill hole 16-052, depth 451.9 to 452.2 feet.
10. Tannish-gray bauxitic underclay from U. S. Bur. Mines drill hole 16-052, depth 480.5 to 480.6 feet.
11. Fragmental kaolinitic underclay from U. S. Bur. Mines drill hole 16-052, depth 488 feet.
12. Type III bauxite deposit. Transported pebbly bauxite with gibbsitic to kaolinitic matrix, from east face of the Harley pit mine of Dulin Bauxite Co., SE¼SE¼, sec. 24, T. 1 N., R. 12 W., Pulaski County.
13. Type III bauxite deposit. Cross-bedded bauxite from ore body in Reichart shaft mine, NW¼SW¼, sec. 2, T. 1 S., R. 12 W., Pulaski County.
14. Type IV bauxite deposit. Transported light-tan bauxite rubble, at or near top of upper bauxite bed, near middle of west wall of the Midwest Pit mine of Midwest Mines Co. in the E½NE¼NE¼, sec. 24, T. 2 S., R. 14 W., Saline County.
15. Harris deposits near Bryant.
16. Ratcliffe mine, Pulaski County.
17. Stuckey pit at Bauxite.
18. Section 26 mine near Bauxite.
19. Hurricane Creek plant.
20. Reynolds. Month-end composite, July, August, September 1947.
21. Reynolds. Month-end composite, June, July, August 1948.
22. Reynolds. Month-end October 1949.
23. Reynolds. Month-end April 1950.
24. Reynolds. Month-end April 1951.
25. Reynolds. Month-end November 1951.
26. Reynolds. Bauxite from Hurricane Creek plant.
27. Bauxitic clay (from Consolidated Chemical Industries plant stockpile), Bierman mine, Pulaski County.
28. Bauxite (from plant stockpile), Bierman mine.
29. Bauxite. Monthly composite, Berry-Mayhan mine; SW¼NE¼, sec. 2, T. 1 S., R. 12 W., Pulaski County. American Cyanamid Co., Berger Plant.
30. Bauxite, low-iron type (raw composite) Dan Rauch mine, SE¼NE¼, sec. 9, T. 1 S., R. 12 W., Pulaski County. American Cyanamid Co.
31. Bauxite, calcined product from blend of bauxite, Dixie mine, SW¼SW¼, sec. 36, T. 1 N., R. 12 W., Pulaski County, and BC-400 mine, SE¼NW¼, sec. 31, T. 2 S., R. 13 W., Saline County. Dulin Bauxite Co.
32. Bauxite, high organic content typical; part granitic and part pisolitic. Bertha Extn. mine, SE¼, sec. 27, T. 2 S., R. 14 W., Saline County. Alcoa Mining Co.
33. Bauxite, granitic, grab sample from conveyor belt. Nielson Underground mine, NW¼NW¼, sec. 26, T. 2 S., R. 14 W., Saline County. Alcoa Mining Co.
34. Bauxite, grab sample by shaft, BC-400 mine, SE¼NW¼, sec. 31, T. 2 S., R. 13 W., Saline County. Dulin Bauxite Co.
35. Bauxite(?) from thin bed in Wilcox formation (core sample), middle of sec. 28, T. 2 S., R. 14 W., Saline County. Alcoa Mining Co.
36. Bauxite, auger drill sample, upper 6 feet; Lewis mine, NW¼NW¼, sec. 9, T. 1 S., R. 12 W., Pulaski County. American Cyanamid Co.
37. Bauxite, auger drill sample, 6 to 12 feet; Lewis mine, NW¼NW¼, sec. 9, T. 1 S., R. 12 W., Pulaski County. American Cyanamid Co.
38. Bauxite, auger drill sample, 12 to 18 feet; Lewis mine, NW¼NW¼, sec. 9, T. 1 S., R. 12 W., Pulaski County. American Cyanamid Co.
39. Bauxite, daily mine production. Harris mine, NE¼NW¼, sec. 36, T. 1 S., R. 14 W., Saline County. Reynolds Mining Co. 12-13-51.
40. Bauxite, daily mine production. Harris mine, NE¼NW¼, sec. 36, T. 1 S., R. 14 W., Saline County. Reynolds Mining Co. 12-14-51.
41. Bauxite, daile mine production. Harris mine, NE¼NW¼, sec. 36, T. 1 S., R. 14 W., Saline County. Reynolds Mining Co. 12-19-51.
42. Bauxite, daily mine production. Harris mine, NE¼NW¼, sec. 36, T. 1 S., R. 14 W., Saline County. Reynolds Mining Co. 12-30-51.
43. Bauxite, daily mine production. Harris mine, NE¼NW¼, sec. 36, T. 1 S., R. 14 W., Saline County. Reynolds Mining Co. 12-31-51.
44. Bauxite, daily mine production (12-31-51), Bray mine, sec. 35, T. 1 S., R. 14 W., Saline County. Reynolds Mining Co.
45. Bauxitic clay, one-day withdrawal (12-19-51). Elrod-Harris low-grade pile, sec. 35, T. 1 S., R. 14 W., Saline County, Reynolds Mining Co.
46. Bauxite. Monthly composite for January, 1952, metal-grade shipments by Alcoa from Arkansas.

has been derived from alkalic rocks and which may therefore be expected to be high in niobium content. Among such localities are the following:

Poços da Caldas, Minas Gerais, Brazil.
Ile de Los, French Guinea, French West Africa.
Gold Coast, western Africa.

Niobium in byproducts of bauxite plants

As stated previously, no data are yet available as to the distribution of niobium among the minerals present in bauxite. However, it is highly improbable from geochemical considerations that it is present in high concentrations as a substituent in the aluminum oxide hydrates or ferric oxide hydrates that constitute the bulk of bauxite ore. Rather, niobium would be expected to be present in solid solution in the tatanium and zirconium minerals. If this is correct, it might reasonably be expected that niobium could be concentrated in some stage of the chemical processing of bauxite ore.

In brief, the treatment of bauxite, as carried out at the Hurricane Creek, Ark. plant of the Reynolds Metal Co., is as follows: The bauxite is digested in hot sodium hydroxide solution. The insoluble material is separated from it as coarse material ("black sand") and fine material ("red mud"). From the solution, $Al_2O_3 \cdot 3H_2O$ is crystallized, leaving "spent liquor." The black sand is discharged into a special tailings pond. The red mud is mixed with $CaCO_3$ plus Na_2CO_3 and sintered, after which it is leached to recover more alumina. The leached residue ("brown mud") is discharged into a tailings pond.

By analyzing samples obtained through the courtesy of Mr. W. W. Binford, superintendent of the Hurricane Creek plant of the Reynolds Metal Co., we have been able to follow the course of the niobium during the process. The analytical data are given in table 3; they show that niobium is concentrated in the material that is insoluble in NaOH solution.

The brown mud, although its niobium content is slightly higher than that of the black sand, is not a very attractive material on which to attempt further concentration because the material is so fine-grained. Work so far has therefore been confined to the black sand. A study by the U. S. Bureau of Mines (Calhoun, 1950) showed that titanium-rich and iron-rich concentrates could be prepared by tabling and by magnetic separation. The data on these concentrates are given in table 4. Through the courtesy of Mr. Binford, samples of these concentrates were obtained by the Geological Survey and analyses for niobium are given in table 4.

The titanium-rich concentrate was further purified in our laboratory by Miss Jewell J. Glass by means of magnetic and heavy-mineral separations. Data on the fractions obtained, given in table 5, show that the niobium content can be raised to over 0.8 percent. It is hoped that further work will permit the analysis of the individual pure minerals.

As a check, a black sand (No. 12 of table 3) was subjected to heavy-mineral and magnetic separations. The procedure was as follows: Approximately 300 grams was crushed to pass 80-mesh. The material passing 270-mesh was not investigated further. The portion passing 80-mesh and retained on 270-mesh was separated twice in methylene iodide (sp gr 3.2). The heavy fraction was then divided into the following magnetic fractions: Magnetic to the hand magnet, magnetic at 0.1, 0.2, 0.3, and 0.5 amperes and nonmagnetic at 0.5 amperes at a slope of 20° towards the nonmagnetic side of a Franz Isodynamic Separator. The results, given in table 6, agree in general with those of tables 4 and 5.

Comparable products from the East St. Louis, Ill., plant of the Aluminum Company of America have not been studied. However, we have fractionated

Table 3.--Niobium content of products of treatment of Arkansas bauxite[a] at the Hurricane Creek plant, Reynolds Metal Co.

No.	Product	Percent Nb	Analyst
1	$Al_2O_3 \cdot 3H_2O$	<0.01	K. J. Murata
2	Calcined alumina	< .01	Do.
3	Spent liquor	< .01	Do.
4	Sinter filtrate	< .01	Do.
5	Red mud	.08	Do.
6	Brown mud	.07	Do.
7	do	.076	Do.
8	do	.069	Do.
9	do	.073	Do.
10	Sinter residue	.09	Do.
11	Black sand	.06	Do.
12	do	.064	H.J. Rose, Jr.
13	do	.062	Do.
14	do	.052	Do.
15	do	.048	Do.
16	do	.048	Do.
17	do	.052	Do.

[a]Samples of red mud from treatment of Surinam and Jamaica bauxite each contained 0.02 percent Nb.

Table 4.--Analyses of titanium- and iron-rich concentrates from black sands from the Hurricane Creek plant, Reynolds Metal Co.

	Ti Concentrate[1]		Fe Concentrate[2]		Ti Concentrate[1]		Fe Concentrate[2]
	(a)	(b)	(a)		(a)	(b)	(a)
TiO_2	41.2	39.9	8.0	CaO	0.6	---	0.5
Fe	20.1	19.9	46.5	Ignition loss	2.2	---	12.2
Mn	8.9	---	---				
Al_2O_3	9.4	---	8.9	Percent Nb	[3]0.67	---	[3]0.032
SiO_2	2.6	---	1.4				

a. After Calhoun (1950). Analysis by U. S. Bureau of Mines.
b. Leonard Shapiro, U. S. Geol. Survey, analyst.
[1]This concentrate was 3.4 percent by weight of the black sand.
[2]This concentrate was 4.5 percent by weight of the black sand.
[3]H. J. Rose, Jr. and Janet D. Fletcher, U. S. Geol. Survey, analysts.

a black sand kindly furnished by Mr. Laurence Litchfield of Alcoa Mining Co. This was produced from an experimental Wilfley-table installation later discontinued (letter from Laurence Litchfield to M. Fleischer, January 21, 1952). Analyses on the fractions, given in table 7, show that the material is similar to the titanium-rich concentrate from the Hurricane Creek plant (table 5) except that it contains much siderite and little magnetite.

Niobium in titanium minerals

Although the geochemical association of niobium with titanium has long been recognized and many analyses of titanium minerals in the literature show appreciable niobium contents, little attention has been paid to the variation of niobium content with the type of rock in which the titanium minerals occur. Determinations of the niobium content of the common titanium minerals are assembled in table 8, omitting only the rarer silicates. Data on the latter are given by Fleischer and Harder (1945) and by Rankama (1948).

Many more analyses are needed on material of known paragenesis, but a few generalizations can be made from the data in table 8. It seems clear that minerals from alkalic rocks and from granitic pegmatites are highest in niobium and that those associated with anorthosites and gabbros are lowest. This is shown best by the data for ilmenite. The largest masses of titanium-rich rocks, such as the huge ilmenite-magnetite deposits associated with the anorthosite-gabbro of the Adirondacks and Quebec, are very low in niobium content; the ilmenite from the beach sands of Florida and India, presumably derived from crystalline rocks, have Nb contents ranging from 0.04 to 0.40 percent; and ilmenite from alkalic rocks is highest (up to 0.9 percent).

The few data available in table 8 indicate that when rutile and ilmenite occur together, rutile generally has the higher niobium content. Of the 35 rutile samples listed in table 8, 12 have Nb contents more than 1 percent. Most rutile, however, will probably be found to contain 0.05 to 0.3 percent Nb, with samples of higher Nb content found in granitic pegmatites and alkalic rocks.

The 20 perovskite analyses listed in table 8 include 13 or 14 from alkalic rocks. Those highest in niobium occur in carbonatites associated with alkalic rocks.

POSSIBILITY OF RECOVERY OF NIOBIUM FROM ARKANSAS BAUXITE AND FROM TITANIUM MINERALS

The data reported as the result of this work suggest the possibility that niobium may be obtained from three sources not now utilized:

1. As a byproduct from Arkansas bauxite.
2. From titanium minerals used in the manufacture of titanium metal.
3. From titanium minerals from alkalic rocks such as the carbonatites.

Table 5.--Analyses of fractions of titanium-rich concentrate referred to in table 4

[Separations by Jewell J. Glass]

	Percent of total	Percent Nb[a]	Percent TiO_2[b]
Original titanium-rich concentrate--	100	0.67	39.9
Fractions:			
Magnetite	12.4	.026	1.3
Calcite and quartz	10.5	(c)	---
Ilmenite plus limonite	73.3	.79-.86	46-50
Mainly zircon, with some rutile, sphene, ilmenite.	3.8	.87	36
	100.0	---	---

[a]Spectrographic analyses by Janet D. Fletcher.
[b]Chemical analyses by Leonard Shapiro.
[c]Not determined.

Table 6.--Analyses of fractions of a black sand from bauxite

[Separations by Marie L. Lindberg; analyses by Janet D. Fletcher]

Material	Percent of total	Percent of -80, +270	Percent Nb
Original black sand	100	---	0.064
Minus 270-mesh	24.7	---	(1)
Float in methylene iodide	10.9	14.5	(1)
Sink in methylene iodide:			
Magnetic to hand magnetate	38.8	51.5	.025
0.1 amp.	6.7	8.9	.035
.2 amp.	4.4	5.8	.064
.3 amp.	12.0	15.9	.14
.5 amp.	2.1	2.8	.66
Nonmagnetic at 0.5 amp.	.4	.5	.45
	100.0	99.9	

[1]Not determined.

Production of bauxite from Arkansas in 1949 was 1,094,924 long tons of dried bauxite equivalent (Mote and Kurtz, 1951). Assuming that the average content of Nb is 0.05 percent, this corresponds to 547.5 long tons or 1.2 million pounds of niobium--80 percent of the amount imported by the United States in the same year.

Table 7.--Analyses of fractions of black sand from Wilfley table (Alcoa)

[Separations by Marie L. Lindberg; analyses by K. J. Murata]

Material	Percent of sample	Percent Nb
Original black sand	100	---
Mainly siderite	55	0.06
About 90 percent ilmenite	32	.57
Ilmenite with much limonite	3	.16
Zircon with some anatase and rutile.	10	.08

The data in table 3 show that niobium is concentrated in the red and brown muds and in the black sands. The data of table 4 to 7 show the niobium to be concentrated in the titanium-rich fraction of the black sands; it is probable that this is also true of the red and brown muds. These might, however, contain more rutile and sphene and less ilmenite than the black sands, but quantitative data are lacking. The problem of obtaining niobium from Arkansas bauxite thus appears to be one of treating a concentrate containing approximately 40 to 50 percent TiO_2 and 0.5 to 0.9 percent Nb.

Most of the ilmenite processed in the United States is used in the manufacture of TiO_2 pigment. This involves solution of the ore in acid, followed by hydrolysis to precipitate titanium dioxide. It is probable that niobium accompanies the titanium in this precipitation and that its recovery would be very difficult. On the other hand, the production of titanium metal is increasing very rapidly. This process involves the chlorination of titanium-rich ore to form $TiCl_4$. Since $TiCl_4$ boils at 136°C and $NbCl_5$ at 243°C, conditions are favorable for obtaining good separations, as recently demonstrated on a laboratory scale by Atkinson, Steigman, and Hiskey (1952). Further research on the process is obviously needed, as well as a study of the economic factors.

Research is also needed on the possibility of using rutile, brookite, or perovskite, such as that obtained from alkalic rocks. As readily seen from the data in table 8, these minerals contain much higher Nb contents than the ilmenite concentrates from Arkansas bauxite, but they lack the advantage of known availability in large tonnages. The possibility of recovering niobium from perovskite-pyrochlore in alkalic rocks has been discussed for the deposits of the Kola Peninsula, U. S. S. R. (Eliseev and Nefedov (1940), Gerasimovsky (1939, 1940); for the deposits of the Kaiserstuhl, Baden, Germany (Leibrandt, 1948); and for the deposits of Tororol, Uganda (Hudson and Dunkin, 1951).

The Geological Survey is continuing its investigations of rutile, brookite, and perovskite at Magnet Cove, Ark., and of similar deposits elsewhere. It is to be hoped that metallurgical researches on the recovery of niobium from these titanium minerals will be carried out by other laboratories.

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Table 8.--Niobium content of titanium minerals

No.	Percent Nb	Locality	Type of occurrence	Analyst
		Rutile (including the variety ilmenorutile) (TiO_2)		
1	0.004	Italy, Trentino, Pfitschthal		Rankama (1948).
2	.01	Norway, Søndeled		Hevesy and others (1929).
3	.013	Arkansas, Magnet Cove	Nepheline syenite	Do.
4	.015	Finland, Tipasjarri		Rankama (1948).
5	.02	Norway, Kragerø	Gabbro	Hevesy and others (1929).
6	.04	Virginia, Roseland	Anorthosite	H. J. Rose, Jr.
7	.04	U. S. S. R., Sugamak		Rankama (1948).
8	.043	Norway, Bamle	Gabbro	Do.
9	.05	Vermont, Hartford		Hevesy and others (1929).
10	.068	Australia, Blumberg		Rankama (1948).
11	.07	Norway, Bamle	Gabbro	Do.
12	.084	U. S. S. R., Kasoi Brod		Do.
13	.13	Finland, Liperinsalo		Do.
14	.15	Switzerland, Kriegalp		Hevesy and others (1929).
15	.18	Norway, Risør	Gabbro	Rankama (1948).
16	.18	Florida	Beach sand	J. D. Fletcher.
17	.19	Norway, Kragerø	Gabbro	Rankama (1948).
18	.20	Italy, Pfitschthal		Hevesy and others (1929).
19	.20	Florida	Beach sand	J. D. Fletcher.
20	.21	Australia	do	Do.
21	.23	Brazil	Alluvial	Do.
22	.26	Florida	Beach sand	Do.
23	.28	Idaho, Clearwater	Placer	Do.
24	1.3	Arkansas, Magnet Cove	Carbonate veins in nepheline syenite	Do.
25	2.0	Texas, Marfa	Tertiary silicified tuffs	Do.
26	4.3	South Dakota, Keystone	Granite pegmatite	Hess and Wells (1911).
27	4.8	Malaya, Kuala Kangsur dist.	Placer	Crook and Johnstone (1912).
28	6.0	W. Australia, Globe Hill	Granite pegmatite	Edwards (1940).
29	12.5	U. S. S. R., Ilmen Mountains	Alkalic rock	Chernik (1921).
30	15.2	do	do	Prior and Zambonini (1908).
31	16.3	Italy, Craveggia	Granite pegmatite	Do.
32	19.5	Brazil, Espirito Santo, Colatina		Tavora and Scorza (1948).
33	20.9	British Guiana	Placer	Smith (1946).
34	22.5	Norway, Ireland	Granite pegmatite	Prior and Zambonini (1908).
35	23.3	W. Australia, Melville	do	Edwards (1940).
		Brookite (TiO_2)		
36	0.01	Switzerland, Riederstobel	Alpine cleft	Hevesy and others (1929).
37	.023	U. S. S. R., Urals	Placer	Rankama (1948).
38	.38	Arkansas, Magnet Cove	Nepheline syenite	Do.
39	2.4	do	Altered novaculite	K.J.Murata and E. L. Hufschmidt.

Table 8.--Niobium content of titanium minerals--Continued

No.	Percent Nb	Locality	Type of occurrence	Analyst
			Anatase (TiO_2)	
40	0.032	Switzerland, Binnenthal	Alpine cleft	Rankama (1948).
41	.047	do	do	Do.
42	1.8	California, Cady Mountain	Granite pegmatite	K. J. Murata.
			Perovskite ($CaTiO_3$) (including the niobian variety dysanalyte and the cerian variety loparite	
43	0.006	U. S. S. R., Urals, Achmatovsk		Rankama (1948).
44	.01	do		Hevesy and others (1929).
45	.47	U. S. S. R., Kola Peninsula	Nepheline syenite	Rankama (1948).
46	3.1	Arkansas, Magnet Cove	do	Mar (1890).
47	3.3	do	do	Rankama (1948).
48	3.4	Germany, Kaiserstuhl	Carbonatite	Houser (1908).
49	5.1	Arkansas, Magnet Cove	do	H. J. Rose, Jr.
50	5.6	do	do	K. J. Murata.
51	5.6-6.8	U. S. S. R., Kola Peninsula (5 samples)	Nepheline syenite	Bykova (1941).
52	11.3	Germany, Kaiserstuhl	Carbonatite	Meigen and Hugel (1913).
53	15.6	Ceylon, Prov. Uva	Limestone in placer	Chernik (1914).
54	18.2	Germany, Kaiserstuhl	Carbonatite	Meigen and Hugel (1913).
			Ilmenite-magnetite ores	
55	0.0002	Finland, Attu Parainen		Rankama (1948).
56	.006	Finland, Otanmaki	Amphibolite	Do.
57	.01	New York, Lake Sanford (9 samples)	Anorthosite-gabbro	E. L. Hufschmidt.
58	.01	Quebec, Allark Lake (2 samples)	do	Do.
59	.01	Costa Rica		Do.
60	.018	Norway, Hitterö	Granite pegmatite	Rankama (1948).
61	.039	U. S. S. R., Ilmen Mountains	Alkalic rocks	Do.
62	.18	U. S. S. R., Vuorikylä		Do.
			Ilmenite ($FeTiO_3$)	
63	0.00002	Norway, Egersund	Anorthosite	Hevesy and others (1929).
64	.0002	South Africa	Gabbro?	Do.
65	.0003	U. S. S. R., Urals, Miask	Granite pegmatite?	Do.
66	.001	India	Placer	Do.
67	.005	Norway, Blaafjeld	Anorthosite	Rankama (1948).
68	.01	New York, Adirondacks (4 samples)	Anorthosite-gabbro	J. D. Fletcher.
69	.01	Quebec, Baie St. Paul (5 samples)	do	Do.
70	.01	North Carolina, Lenoir	Metamorphosed basic rocks	Do.
71	.01	Virginia, Piney River	Anorthosite	Do
72	.01	Virginia, Roseland		Do
73	.01	Norway (3 samples)	Anorthosite?	Do.

74	.01	Norway	Placer	Hevesy and others (1929).
75	.039	Florida	Beach sands	J. D. Fletcher.
76	.040	do	do	Do.
77	.05	Australia	do	Do.
78	.065	Florida	do	Do.
79	.07	do	do	Do.
80	.085	do	do	Do.
81	.09	Florida	do	Do.
82	.090	India, Quilon	do	Do.
83	.095	do	do	Do.
84	.10	Florida	do	Do.
85	.12	do	do	Do.
86	.14	India, Quilon	do	Do.
87	.18	U. S. S. R., Azov region	Beach sands, derived from granite pegmatite.	Yurk and Bresser (1940).
88	.20	Florida	Beach sand	J. D. Fletcher.
89	.28	California, Tulare Co.	Granite pegmatite	Do.
90	.35			Borowsky and Blochin (1937).
91	.4	U. S. S. R., Mariupol	Nepheline syenite	Yurk and Bresser (1940).
92	.5	Uganda, Tororol	do	H. J. Rose, Jr.
93	.4-.9	U. S. S. R., Ilmen Mountains	do	Panteleev (1938).
94	.57-.86	Arkansas bauxite (4 samples)	Bauxite	J. D. Fletcher.
		Sphene ($CaTiSiO_5$) (including keilhauite variety)		
95	0.0001	Norway, Kragerø		Hevesy and others (1929).
96	.001	Switzerland, St. Gotthard		Do.
97	.001	Italy, Zillerthal		Do.
98	.002	Switzerland, Binnenthal		Do.
99	.002	Norway, Arendal		Do.
100	.011	Norway, Kragerø		Do.
101	.02	Norway, Søndeled		Do.
102	.02	U. S. S. R., Urals, Miask	Granite pegmatite	Sahama (1946).
103	.023	Norway, Arendal		Hevesy and others (1929).
104	.03	Switzerland, Binnenthal		Rankama (1948).
105	.03	Finland, Ylojarvi	Gabbro	Sahama (1946).
106	.09	Canada, Eganville		Hevesy and others (1929).
107	.10	Canada, Pontiac Co.		Rankama (1948).
108	.13	Norway, Risør	Gabbro	Do.
109	.15	Finland, Iivaara	Nepheline syenite	Do.
110	.20	Sweden, Hajstorp		Do.
111	.20	Germany, Aschaffenburg	Nepheline syenite	Do.
112	.21	U. S. S. R., Transbaikalia, Sviatoy Noss		Do.
113	.24	U. S. S. R., Kola Peninsula	Nepheline syenite	Sahama (1946).
114	.25	do	do	Rankama (1948).
115	.48	Finland, Parainen	Limestone	Sahama (1946).
116	.77	U. S. S. R., Kola Peninsula	Nepheline syenite	Do.
117	.84	Norway, Kragerø		Rankama (1948).
118	1.06	U. S. S. R., Kola Peninsula	Nepheline syenite	Sahama (1946).
119	1.12	U. S. S. R., Nuolainniemi, Core	Granite pegmatite	Do.
120	2.3	U. S. S. R., Nuolainniemi, Shell	do	Do.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION

REFERENCE SLIP

DATE 7-21, 1953

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1. Code 230, Rm. 4070
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DMEA-2841
Idm-E523

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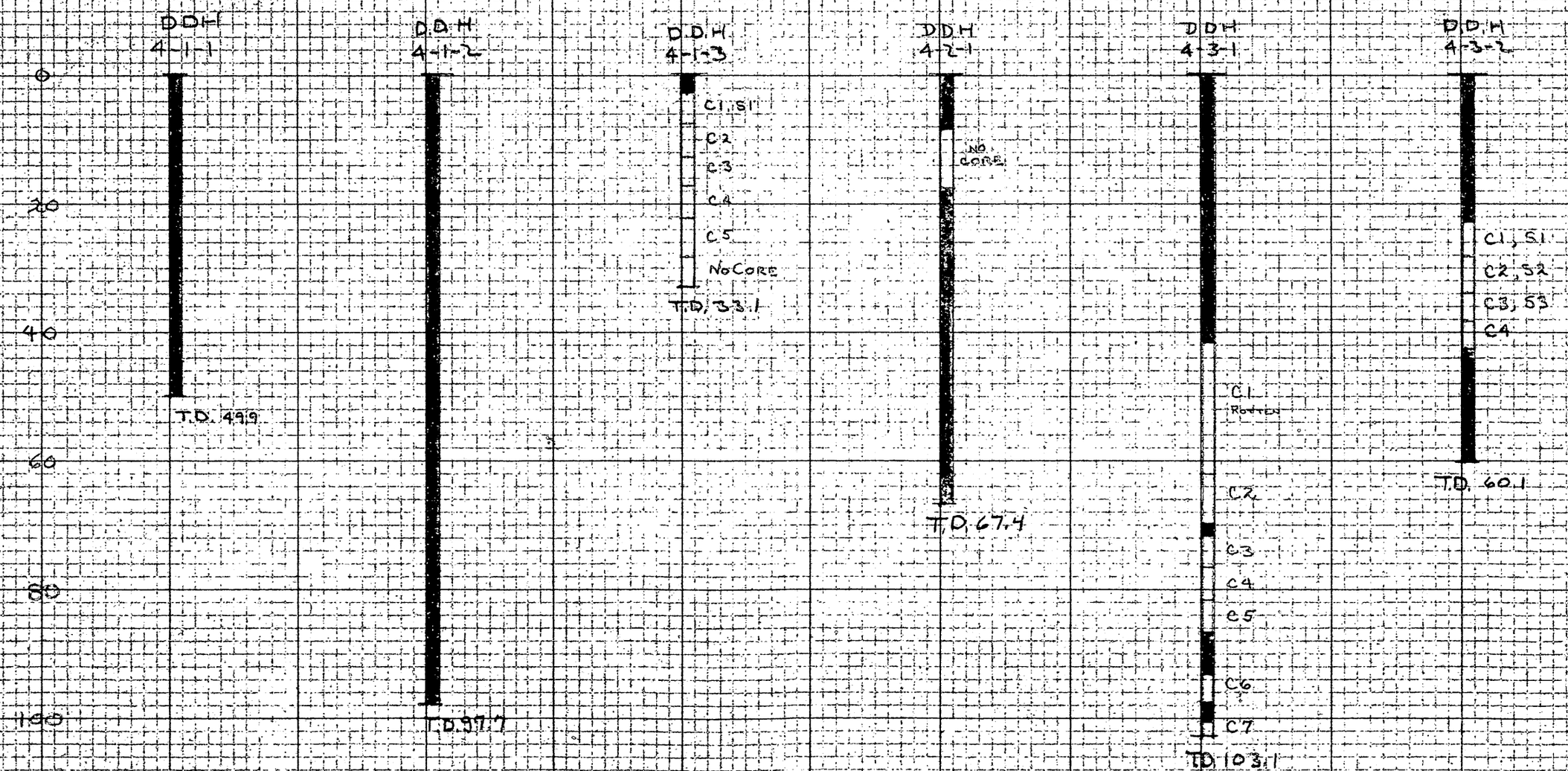

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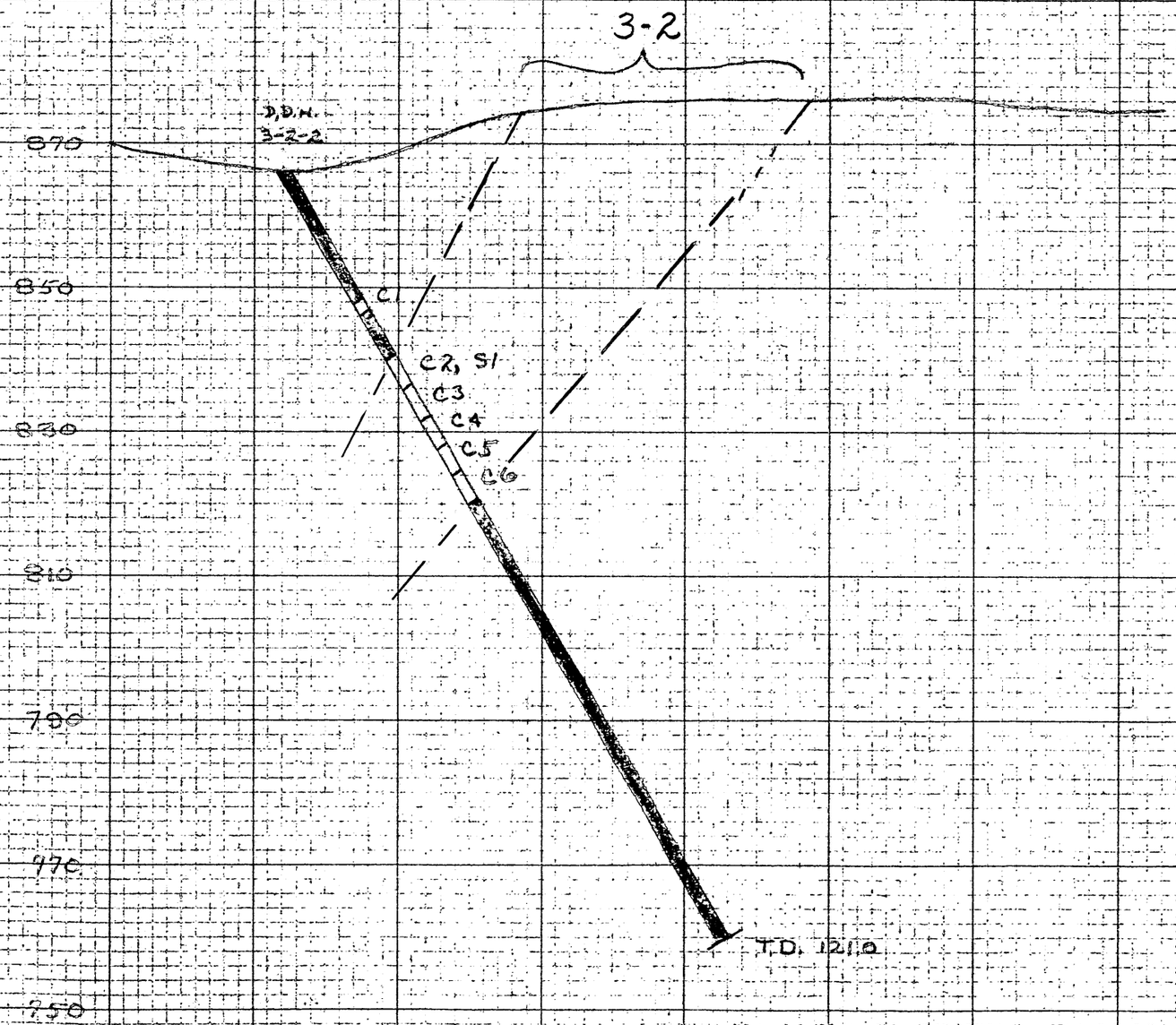

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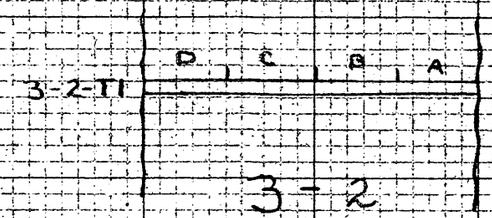

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EXHIBIT

NO. 7

MINERAL INDUSTRY SURVEYS

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

Douglas McKay, Secretary J. J. Forbes, Director

For immediate release MINERAL MARKET REPORT MMS NO.2153
(Replaces December monthly report No. 24)

TIN IN 1952

(PRELIMINARY ANNUAL FIGURES)

Total domestic consumption of tin decreased 18 percent in 1952, according to the Bureau of Mines, United States Department of the Interior. Preliminary figures for 1952 based upon monthly report Form NPAF-7 show the use of primary tin was 20 percent and of secondary 10 percent less than in 1951. Primary consumption was the lowest since 1943. Imports of metal nearly trebled and permitted a substantial tonnage to be added to the National stockpile. The total consumed in manufacturing in 1952 was 73,384 long tons (45,299 of primary - including 211 tons contained in copan produced by the Texas City smelter - and 28,085 of secondary). In 1951, tin consumption in manufacturing totaled 89,505 tons (56,884 was primary, 31,285 secondary, and 1,336 tons plant losses). Consumption was at its lowest rate during the second quarter, and at its highest during the last quarter. Total tin used in December was 6,965 long tons, an increase of 5 percent compared with 6,636 tons in November. Raw material imported in 1952, in the form of 94 percent tin and 6 percent lead or copper alloys, with an estimated total tin content of 6,100 long tons, has not been included in the figures. This was not under formal quantitative or allocation control. The supply of tin reached virtual balance with defense and essential civilian demand in 1952. Curbs on the use of tin were relaxed progressively by National Production Authority, by amendments to control Order M-8, on July 21, August 1, and December 30, 1952. Effective August 1, private firms were permitted to resume importing tin from suppliers of their own choosing. On August 26, the Defense Production Administration moved tin from List I, materials in short supply, to List II, materials in approximate balance. Allocation controls over pig tin were removed effective January 1, 1953. (On February 6, 1953 all controls over uses and inventories of tin were removed and announcement was made of the revocation of Orders M-8, M-24, M-25, M-26, and M-27, and amendment of Regulation 1, inventory provisions.)

Five items - tin plate, solder, bronze, babbitt and tinning - accounted for most of the tin consumed in 1951 and 1952. Tin platers, the largest consumers of primary tin, decreased their use 9 percent, but used 63 percent of the total primary in 1952 against 54 percent in 1951. A prolonged steel strike interrupted operations of most of the tin plate mills in June and July. Thereafter, their average monthly consumption increased and during the last five months of 1952 it was 17 percent above the average monthly rate for the whole of 1951. Solder, next in rank, required 21 percent less than in 1951, mainly by the substitution of a large tonnage of imported tin-base alloy for pig tin. Babbitt and tinning declined 25 and 18 percent respectively. In respect to total tin used, bronze maintained its position as the second largest consumer, but its total use decreased 4,300 tons. All other tin consuming products also recorded decreases in 1952.

Prepared March 4, 1953, by Abbott Renick and John B. Umhau, under the supervision of C. H. Johnson, Chief, Base Metals Branch, Minerals Division.

Tin stocks held by the Government (RFC) and industry - comprising pig tin, tin in ore, raw materials in process, and other but excluding the strategic stockpile and metal afloat enroute to the United States - increased from 40,448 long tons at the beginning of 1952 to 61,413 at the end. The progressive decline in industry stocks evident throughout 1951 and most of 1952 was halted after lifting of the ban on private importing. Industrial stocks of pig tin were at a low ebb during the first and third quarters, but they increased 2,948 long tons in the final quarter and totaled 12,728 tons December 31, 1952. It has been estimated that about 5,300 long tons of pig tin were afloat to the United States at the end of 1952.

Imports of metallic tin in 1952 totaled 80,457 long tons compared with 28,255 in 1951. Malaya was the principal source in 1952, furnishing 57 percent of the total. Other important sources of metal imported in 1952 include Netherlands (20 percent), United Kingdom (11 percent), Belgium-Belgian Congo (11 percent), and other (1 percent). Receipts were at their lowest rate in the first quarter and their highest in the second. Under the United States-United Kingdom mutual assistance agreement of January 1952, the United States acquired 20,000 long tons of tin, most of which was grade A quality at $1.18 per pound f.o.b. foreign port of delivery. Receipts of ore in terms of metal were 11 percent less than in 1951, principally owing to a decrease of 42 percent in imports from Indonesia. Bolivia, the main source of tin ore (accounting for 48 percent of the total) furnished 12,639 tons in 1952, or 3 percent less than in 1951. Ore and metal imports were augmented by 7,711 long tons (gross weight - chief value tin) of alloys brought into the country in 1952, mainly from the Netherlands in the form of 94-percent tin alloy. Imports for consumption of this class were 230 tons in December, compared with 649 in November 1952. Exports of metallic tin in 1952 were 380 long tons with Canada as the destination of most of it.

The Government-owned Longhorn smelter at Texas City, Texas, produced 22,802 long tons of tin, including the tin content of Copan. The output of the smelter was the smallest since 1943 due to shortage of ore and complete shutdown for two-and-a-half months by a strike. In November, 1952, production was 4,020 long tons of 3-Star from concentrates, the highest recorded for any month by the plant. In December the plant produced 3,705 long tons of 3-Star from concentrates and upgraded 45 tons of 1-Star to 3-Star. At the close of 1952 concentrates at foreign ports, afloat, in storage or in transit in the United States, at smelter and in process contained 25,209 long tons of tin. Domestic mine production of tin was again insignificant; only 100 long tons of tin were produced in 1952 compared with 88 tons in 1951.

The selling price of tin was maintained by the Reconstruction Finance Corporation at $1.03 a pound from August 1, 1951, to January 21, 1952. As a result of the British agreement announced at the White House on January 18, 1952, the price was raised to $1.215 on January 22, at which level the RFC price for resale remained for the rest of 1952. The RFC price averaged $1.20519 for 1952. The RFC was the sole importer of tin from March 12, 1951 until resumption of private importing for resale was permitted on August 1, 1952 when the outside market reopened. The outside market for prompt tin was nominal until August 11 when the price was first quoted at $1.21 a pound. The five-month average from August through December was $1.21305. The monthly average price on the open market ranged from $1.21152 in August to $1.21472 in December, 1952. The lowest price for the year on the outside market was $1.2075 on October 16. Effective September 12, 1952, Office of Price Stabilization established a ceiling price on tin of $1.215 a pound f.o.b. New York. (On February 13, 1953, OPS issued a sweeping decontrol order which removed the ceiling price on tin).

World mine production of tin increased in 1952. Preliminary figures show that the total output was 172,500 long tons compared with 169,600 in 1951. In 1952 the tin fields of Malaya accounted for 33 percent of the total, Indonesia 20 percent, Bolivia 20 percent, Belgian Congo 8 percent, Thailand (Siam) 5 percent, Nigeria 5 percent, and all the remaining sources 9 percent.

Consumption of primary and secondary tin in the United States in 1951 and 1952, in long tons

Industrial plants	1951	1952					
		January-September	October	November	December	October-December	Total
Stocks beginning of period	31,856	20,764	18,408	19,745	19,826	18,408	20,764
Receipts	81,139	52,107	8,807	6,955	9,348	25,110	77,217
Supply	112,995	72,871	27,215	26,700	29,174	43,518	97,981
Stocks at end of period	20,764	18,408	19,745	19,826	21,901	21,901	21,901
Total processed	92,231	54,463	7,470	6,874	7,273	21,617	76,080
Intercompany scrap transactions	2,726	1,941	209	238	308	755	2,696
Consumed in manufacturing	89,505	52,522	7,261	6,636	6,965	20,862	73,384
Primary	56,884	31,780	4,709	4,311	4,499	13,519	45,299
Secondary	31,285	20,742	2,552	2,325	2,466	7,343	28,085
Plant losses	1,336	1/	1/	1/	1/	1/	1/

1/ Not separately reported.

Consumption of tin in the United States in 1951 and 1952, by finished products, in long tons of contained tin

	1951			1952 1/		
	Primary	Secondary	Total	Primary 2/	Secondary 2/	Total
Tin & terneplate	30,606	683	31,289	28,356	187	28,543
Solder	13,066	6,744	19,810	8,763	6,940	15,703
Babbitt	2,493	3,360	5,853	2,097	2,282	4,379
Brass & bronze	4,838	16,934	21,772	3,841	13,631	17,472
Collapsible tubes & foil	832	208	1,040	628	73	701
Tinning	2,431	277	2,708	2,224	--	2,224
Pipe & tubing	133	94	227	102	81	183
Type metal	120	1,694	1,814	80	1,643	1,723
Chemicals including tin oxide	374	826	1,200	556	457	1,013
Copan	592	--	592	211	--	211
Miscellaneous	1,399	465	1,864	1,120	112	1,232
Sub-total	56,884	31,285	88,169	47,978	25,406	73,384
Secondary pig tin 2/	--	--	--	-2,679	2,679	--
Total	56,884	31,285	88,169	45,299	28,085	73,384

1/ Preliminary figures

2/ Distribution of primary includes secondary not separable by uses; adjustment made in total.

Consumption of tin in the United States in 1952,
by finished products, in long tons of contained tin

	1952														
	January-September			October			November			December			October-December		
	Primary	Secondary	Total	Primary 1/	Secondary 1/	Total	Primary 1/	Secondary 1/	Total	Primary 1/	Secondary 1/	Total	Primary 1/	Secondary 1/	Total
Tin & Terneplate	19,575	130	19,705	3,018	21	3,039	2,754	17	2,771	3,009	19	3,028	8,781	57	8,838
Solder	6,057	5,120	11,177	920	664	1,584	858	552	1,410	928	604	1,532	2,706	1,820	4,526
Babbitt	1,499	1,702	3,201	210	209	419	190	187	377	198	184	382	598	580	1,178
Brass & bronze	2,957	10,114	13,071	311	1,222	1,533	275	1,176	1,451	298	1,119	1,417	884	3,517	4,401
Collapsible tubes & foil	431	53	484	63	9	72	71	9	80	63	2	65	197	20	217
Tinning	1,626	--	1,626	194	--	194	202	--	202	202	--	202	598	--	598
Pipe & tubing	79	58	137	8	7	15	8	9	17	7	7	14	23	23	46
Type metal	63	1,212	1,275	5	135	140	6	136	142	6	160	166	17	431	448
Chemicals incl. tin oxide	430	339	769	85	29	114	37	43	80	4	46	50	126	118	244
Copan	190	--	190	21	--	21	--	--	--	--	--	--	21	--	21
Miscellaneous	792	95	887	122	8	130	100	6	106	106	3	109	328	17	345
Sub-total	33,699	18,823	52,522	4,957	2,304	7,261	4,501	2,135	6,636	4,821	2,144	6,965	14,279	6,583	20,862
Secondary pig tin 1/	-1,919	1,919	--	-248	248	--	-190	190	--	-322	322	--	-760	760	--
Total	31,780	20,742	52,522	4,709	2,552	7,261	4,311	2,325	6,636	4,499	2,466	6,965	13,519	7,343	20,862

1/ Distribution of primary includes secondary not separable by uses; adjustment made in total.

Tin stocks in the United States at the end of 1951
and selected periods in 1952,
in long tons

	1951	1952				
		March	June	September	November	December
Grand total	40,448	37,853	58,837	61,165	61,151	61,413
Industry total	21,817	20,216	21,177	20,257	21,000	22,939
At plants - total	20,764	19,086	20,215	18,408	19,826	21,901
Pig tin	10,384	8,124	9,464	7,931	9,488	11,690
In process	10,380	10,962	10,751	10,477	10,338	10,211
Other pig tin - total	1,053	1,130	962	1,849	1,174	1,038
In transit in U. S.	971	1,011	923	1,486	1,093	507
Jobbers - importers	82	119	39	363	81	531
Government (RFC) - total	18,631	17,637	37,660	40,908	40,151	38,474
Pig tin	6,753	9,004	15,904	15,534	13,659	13,265
Ores - total (tin content)	11,878	8,633	21,756	25,374	26,492	25,209
In foreign ports or afloat	1,107	1,007	13,571	11,454	12,656	11,868
In U. S.	10,771	7,626	8,185	13,920	13,836	13,341

Pig tin and copan production in the United States in 1951 and 1952, in long tons

	1951	1952					
		January-September	October	November	December	October-December	Total
Pig tin							
Texas City Smelter	31,526	11,502	3,364	4,020	3,705	11,089	22,591
Secondary plants	3,690	1,919	248	190	322	760	2,679
Copan	700	226	25	--	--	25	251

Tin imported for consumption in the United States and exported in 1951 and 1952, by countries, in long tons 1/

	1951 2/	1952					
		January-September	October	November	December	October-December	Total
Imports							
Ore (tin content)							
Belgian Congo	1,585	1,192	--	--	--	--	1,192
Bolivia	13,085	6,432	2,545	1,596	2,066	6,207	12,639
Indonesia	11,684	4,178	1,634	507	438	2,579	6,757
Siam	3,114	3,624	590	--	677	1,267	4,891
Other	153	742	100	74	96	270	1,012
Total	29,621	16,168	4,869	2,177	3,277	10,323	26,491
Metal							
Belgian Congo	915	1,125	--	--	150	150	1,275
Belgium	5,501	6,025	660	400	445	1,505	7,530
China	55	--	--	--	--	--	--
Malaya	6,986	33,437	3,853	3,525	5,076	12,454	45,891
Netherlands	12,837	12,420	1,510	1,354	1,091	3,955	16,375
United Kingdom	1,846	7,224	834	569	303	1,706	8,930
Other	115	303	26	12	115	153	456
Total	28,255	60,534	6,883	5,860	7,180	19,923	80,457
Exports (metal)	1,513	198	20	139	23	182	380

1/ Compiled from records of the U. S. Department of Commerce

2/ Revised figures.

Alloys, chief value tin - n.s.p.f.
(including alloy scrap)
imported for consumption in the United States in 1952,
in long tons 1/

Countries of Origin	Gross Weight
Belgium-Luxembourg	300
Denmark	125
France	137
Italy	50
Netherlands	5,806
United Kingdom	386
West Germany	804
Other	103
Total	7,711

1/ Compiled from records of the U. S. Department of Commerce.

World mine production of tin (content of ore), by countries in 1951 and 1952, in long tons 1/

Country	1951	1952
Malaya	57,168	56,837
Indonesia	30,986	35,003
Thailand	9,502	9,473
Nigeria.	8,529	8,270
Belgian Congo.	13,669	13,320
Bolivia.	33,130	34,800
Others	16,616	14,797
Total.	169,600	172,500

1/ Preliminary - partly estimated.

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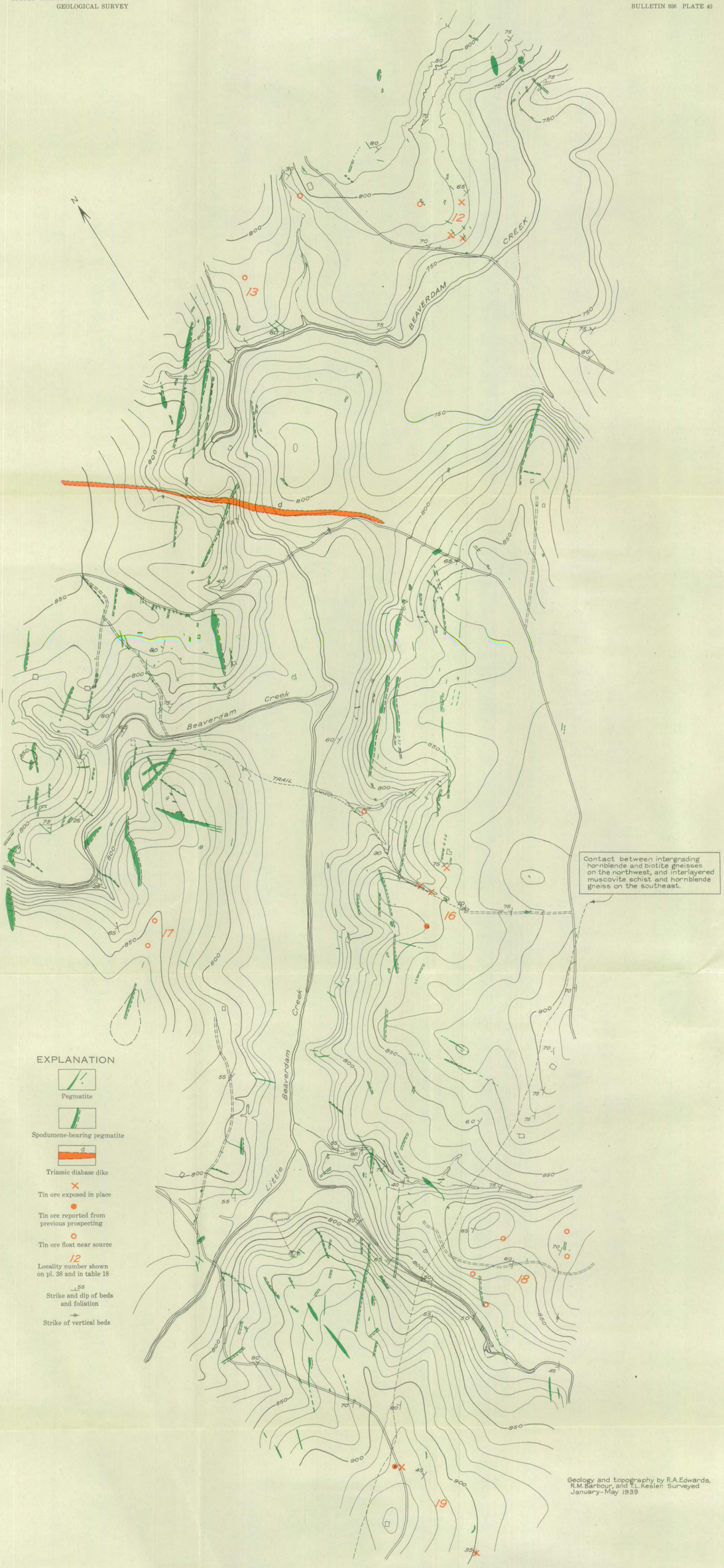

GEOLOGIC MAP OF THE BEAVERDAM CREEK AREA OF THE CAROLINA TIN-SPODUMENE BELT

500 0 1,000 Feet

Contour interval 10 Feet. *Datum is mean sea level*

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

GEOLOGICAL SURVEY
W. C. Mendenhall, Director

Bulletin 936-J

THE TIN-SPODUMENE BELT OF THE CAROLINAS

A PRELIMINARY REPORT

BY

T. L. KESLER

Strategic Minerals Investigations, 1942
(Pages 245-269)

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THE TIN-SPODUMENE BELT OF THE CAROLINAS

A PRELIMINARY REPORT

By T. L. Kesler

ABSTRACT

Cassiterite and spodumene, of possible economic importance, occur in a belt, 24.5 miles long and 1.8 miles in maximum width, extending southwestward from Lincolnton to Grover, N. C. This belt is in the Piedmont province, an upland with an average altitude of 1,000 feet, and is readily accessible by rail and highway. The region is underlain by crystalline limestone, quartzite, schists, gneisses, and granite. The rocks strike northeast and, in most of the belt, dip steeply northwest. Most of them are deeply weathered.

The tin-spodumene belt lies mostly in North Carolina between Lincolnton and the State line. Cassiterite occurs sparsely in hundreds of spodumene-bearing pegmatite bodies, which were emplaced in joints where the rocks are uniformly competent, and parallel to the layering where competent and incompetent rocks are interlayered. Locally, cassiterite is sufficiently abundant in the pegmatite bodies and in closely associated greisen (quartz-muscovite rock) to be of possible commercial value. There are at least 91 such deposits of potential tin ore in North Carolina, and 1 near Gaffney in South Carolina.

The deposits vary widely in thickness along their strike and dip; about 18 are more than a foot thick. The maximum strike length is 275 feet. Little is known about the downward extensions of the bodies, but irregular shapes and unpredictable dimensions are to be expected. The tin content of the ore ranges in general from a trace to more than 6 percent, and the grade in any one deposit is likely to be far from uniform. Records of production from the Ross mine, near Gaffney, indicate that its ore averaged possibly 2 percent of tin; this is probably exceptional. Small placer deposits, of which three are known, and thin cassiterite-bearing soils of small extent, might yield 150 tons of metallic tin, but these deposits are likewise low in grade.

Because of their small size, low grade, and scattered distribution, the deposits are not being mined at present, and it seems unlikely that any now exposed could be mined profitably unless the price of tin became extremely high.

Many of the pegmatite bodies contain 15 percent or more of spodumene, and unusually rich parts of bodies average from 30 to 50 percent. The commercial possibilities of the spodumene probably exceed those of the cassiterite, and it is estimated that two unusually favorable areas contain a reserve of at least 650,000 tons of spodumene (more than 20,000 tons of metallic lithium) to a depth of 100 feet.

INTRODUCTION

The tin-spodumene belt of the Carolinas is a long and narrow strip of the southeastern Piedmont (see fig. 27) that contains many bodies of tin- and spodumene-bearing pegmatite. The belt lies about 50 miles east of the Blue Ridge and 85 miles west of the Fall Line. The Piedmont is a moderately dissected upland having a general altitude here of about 1,000 feet. A few ridges and peaks consisting of unusually resistant rocks rise above this level; an irregular ridge known as Kings Mountain which lies 2 miles east of the belt, near the town of Kings

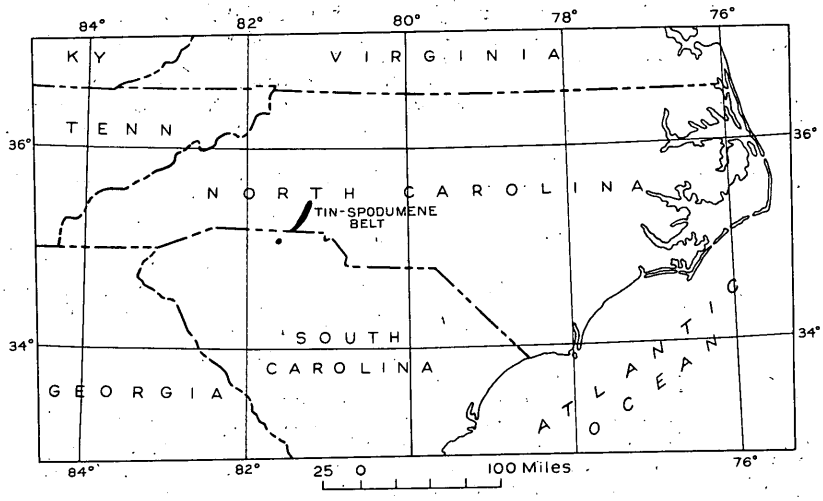

Figure 27.—Index map showing location of the Carolina tin-spodumene belt.

Mountain, reaches an altitude of 1,705 feet. (In this report the name Kings Mountain refers to the town and not the ridge.) The belt is drained by the South Fork and Broad Rivers. Most of it is cultivated, but steep slopes and rocky areas, such as those underlain by the pegmatite bodies described below, are wooded.

Paved highways between the towns and villages, and interconnecting, well-graded roads make the entire region accessible.

From Kings Mountain southward to the State line, the main line of the Southern Railway and U. S. Highway No. 29 run parallel to the belt and less than a mile west of it. Lincolnton is served by the Seaboard Airline Railroad.

Most of the hundreds of pegmatite bodies contain a little cassiterite together with spodumene and other minerals that are not found in the pegmatites of the surrounding region. Locally, in the pegmatite and in greisen (quartz-muscovite rock) associated with it, cassiterite is abundant enough to be of possible commercial value. It is only these relatively rich occurrences of cassiterite that are referred to in this report as deposits. Deposits, in this sense of the word, occur at short intervals from a point 2 miles southeast of Lincolnton to a point 0.8 mile due east of Grover, N. C., very near the State line, and coincide with the occurrence of spodumene. The length of the belt is 24.5 miles, and the maximum width, southeast of Crouse, 1.8 miles; the belt contains at least 91 deposits of possible commercial grade, most of which, however, are very small. The only known tin deposit in South Carolina occurs 12 miles to the southwest, near Gaffney, in a pegmatite that apparently contains no spodumene.

Field work and acknowledgments

The field work on which this report is based comprised (1) detailed plane-table mapping of six local areas in the belt (four of which are outlined on plate 38), and (2) reconnaissance examination of the remainder of the belt and of areas extending 6 miles beyond the extreme occurrences of cassiterite at Lincolnton and Gaffney. Most of the work was carried on during the months from October to May inclusive in 1938-39 and 1939-40, but some field work was done as early as August 1938 and as late as April 1942. The plane-table work during the first season was done largely by P. M. LeBaron, R. A. Edwards, R. M. Barbour, and

H. E. LeGrand, that during the second season by H. E. LeGrand and J. C. Morris. LeGrand and Morris also made most of the reconnaissance examinations of deposits lying outside the areas mapped in detail.

Helpful discussion and advice on specific problems were contributed by W. T. Schaller and C. S. Ross, though the interpretations presented are those of the writer. Charles Milton identified columbite-tantalite, tin-bearing rutile, molybdenite, and a complex group of supergene phosphates and oxides. H. G. Ferguson, F. C. Calkins, W. C. Smith, and T. B. Nolan reviewed the manuscript, and made numerous helpful suggestions.

Previous work

Material relating to the geology, mineralogy, and economic development of the tin deposits and associated spodumene is contained in 44 reports, articles, and maps. The more important of these are listed in the following annotated bibliography.

(1) Dabney, C. W., Jr., Note on cassiterite from Kings Mountain, N. C.: Elisha Mitchell Sci. Soc. Jour., 1883-84, pp. 79-81, 1884.

The first published account of the discovery of cassiterite in the belt; contains two analyses of the mineral that erroneously list tungsten as a constituent.

(2) Furman, J. H., The tin deposits of North Carolina: New York Acad. Sci. Trans., vol. 8, pp. 136-145, 1889.

An illustrated account of observations on the geology of the belt by the first, and one of the most active, prospectors. Contains useful facts, together with doubtful interpretations.

(3) Ledoux, A. R., Tin in North Carolina: Eng. and Min. Jour., vol. 48, pp. 521-522, 1889.

A record of the general results of tin prospecting by open cuts, shafts, and diamond drilling in a portion of the belt about 2 miles long, presumably southwest of Kings Mountain.

(4) Pratt, J. H., and Sterrett, D. B., The tin deposits of the Carolinas: North Carolina Geol. Survey Bull. 19, 62 pp., 1904.

Describes the deposits and discusses their origin.

(5) Graton, L. C., A reconnaissance of some gold and tin deposits of the Southern Appalachians: U. S. Geol. Survey Bull. 293, pp. 31-57, 1906.

Gives a good account of the discovery and early prospecting of the deposits, detailed descriptions of the Jones, Faires, and Ross mines, and an estimate of the total production of the belt to May 1905. Pegmatites of various compositions, interpreted in the present report as the product of successive mineral-bearing solutions that circulated with various degrees of freedom, were regarded by Graton as representing a genetically related series of intrusions.

(6) Sloan, Earle, Catalogue of the mineral localities of South Carolina: South Carolina Geol. Survey, ser. 4, Bull. 2, pp. 85-93, 1908.

Describes and illustrates workings and geologic features at the Ross mine, and records the total production of concentrates from pegmatite and placer to December 1906.

(7) Keith, Arthur, and Sterrett, D. B., Tin resources of the Kings Mountain district, N. C. and S. C.: U. S. Geol. Survey Bull. 660-D, pp. 123-146, 1917.

A general discussion of the geology of the region, with descriptions of the principal mines and prospects, most of which were abandoned at the time.

(8) Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Gaffney-Kings Mountain folio (No. 222), 1931.

Contains part of the economic material in Bulletin 660-D, but is considerably more specific in treatment of geology. The folio does not recognize the genetic relation, found in the present study, between schistose crystalline limestone and the gneisses and schists that enclose the pegmatite bodies.

(9) Fraas, Foster, and Ralston, O. C., Beneficiation of spodumene by decrepitation: U. S. Bur. Mines Rept. Inv. 3336, 13 pp., 1937.

The natural α spodumene in pegmatite matrix, heated to 1,050° to 1,180° Centigrade, was converted to β spodumene, which was selectively disintegrated by gentle grinding and separated from the coarser quartz and feldspar.

(10) Boyd, J. E., Jr., Pyrometric properties of spodumene-feldspar mixtures: Am. Ceramic Soc. Jour., vol. 21, pp. 385-388, 1938.

Fusion tests of mixtures containing 20 to 40 percent of spodumene with either potash or soda feldspar showed that P. C. E. values were lowered several cones below those of the feldspars alone. The addition of spodumene to a mixture of equal parts of the feldspars showed even greater contrast. The paper includes an analysis of the spodumene, which is quoted on page 269.

471319 O - 42 - 2

(11) Hess, F. L., The spodumene pegmatites of North Carolina: Econ. Geology, vol. 35, pp. 942-966, 1940.

Discusses the origin of the pegmatite in the tin-spodumene belt and the quality and possible amount of the spodumene. Some of the pegmatite minerals are believed to have been deposited, in several stages, by solutions that circulated through fractures in assumed prelithium, granitic pegmatite, whereas, in the present report, all of the minerals are believed to have been deposited by solutions in successive stages, but in different order, and an "original" pegmatite is not postulated.

(12) Norman, James, and Gieseke, E. W., Beneficiation of spodumene rock by froth flotation: Am. Inst. Min. Met. Eng. Tech. Pub. 1161, (Mining Technology), 9 pp., April 1940.

Samples of spodumene-bearing pegmatite from two localities were ground and treated with solutions of NaOH and NaOH with Na_2S to remove films of weathering products from the mineral grains. The films interfered with the flotation of spodumene with a soap collector, in contrast to feldspar and quartz. After cleaning, concentrates containing from 5.40 to 6.59 percent Li_2O were obtained, principally with the use of oleic acid; a mixture of spodumene and feldspar containing 4.98 percent Li_2O was separated by similar treatment.

(13) Engel, E. L., and Shelton, S. M., Tin ore from North Carolina, in Ore-testing studies, 1939-40: U. S. Bur. Mines Rept. Inv. 3564, p. 15, 1941.

Tin ore with feldspathic gangue, containing 1.06 percent tin, crushed to pass 10 mesh, was separated into four sand products in a laboratory hydraulic classifier. The sand products were treated on a laboratory concentration table, and yielded concentrates that assayed 68.81 percent tin, or 92.3 percent of the total tin.

(14) Gabriel, Alton, Slavin, Morris, and Carl, H. F., Minor constituents in spodumene: Econ. Geology, vol. 37, pp. 116-125, 1942.

Spectrographic analysis of spodumene from three areas in the belt showed the presence of minor amounts of Fe_2O_3, MnO, TiO_2, SnO_2, Ga_2O_3, Na_2O, and K_2O; one of the samples contained Rb_2O. On the basis of X-ray and petrographic studies, it is concluded that the impurities are probably isomorphous replacements in the crystal structure of the spodumene.

Production

Some production of cassiterite concentrates from the Carolinas is recorded [1/] for the years 1903-04, 1906-07, 1910,

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1/ Mineral Resources U. S. and Minerals Yearbook.
Pratt, J. H., The mining industry in North Carolina during 1911 and 1912: North Carolina Geol. Survey Econ. Paper 34, pp. 16, 73, 1914.

1912-13, 1918, 1930, and 1937, but specific tonnage is given in only a few instances. Graton [2] estimated that the total production of metallic tin to May 1905 probably did not exceed 50 short tons, a little more than half of which came from the Ross mine near Gaffney. Sloan [3] reported that the Ross mine alone had produced a total of approximately 130 tons of concentrates (about 85 tons of metallic tin) up to December 1, 1906, which seems excessive in view of Graton's estimate of 19 months earlier. But even if Sloan's figure for the Ross mine is correct, the recorded production of metallic tin from the entire belt is not more than 110 short tons. Dates and scales of operations subsequent to 1906 are known only approximately, but it seems unlikely that additional unrecorded production would raise the total above 300 tons.

GEOLOGY

Country rocks

Most of the tin-spodumene belt is underlain by interlayered hornblende-biotite gneiss and muscovite schist and gneiss, accompanied by very small quantities of chloritic gneiss and schist, quartz-tourmaline gneiss, augite-andesine gneiss, and enstatite-oligoclase gneiss. These foliated rocks were mapped by Keith and Sterrett [4] as parts of the Roan gneiss and Carolina gneiss, and regarded as pre-Cambrian, whereas the crystalline limestone and interlayered fine-grained muscovite schist and quartzite which crop out in a nearly continuous zone along the eastern side of the belt were regarded as Cambrian. The observations made during the present investigation indicate that, at least in the areas mapped in detail, the gneisses are strongly

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2/ Graton, L. C., A reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, pp. 9, 54, 1906.

3/ Sloan, Earle, A catalogue of the mineral localities of South Carolina: South Carolina Geol. Survey, ser. 4, Bull. 2, p. 92, 1908.

4/ Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Gaffney-Kings Mountain folio (No. 222) 1931.

metamorphosed parts of the marble-schist-quartzite sequence, and not older rocks. Neither sharp contacts nor the strike faults mapped by Keith and Sterrett were found to separate the two groups of rocks; there appears, rather, to be a gradational zone between them in which transitional types of rocks occur. The rocks strike generally northeast and dip steeply northwest except in the vicinity of Gaffney, where they dip southeast.

Large, extremely irregular bodies of granitic rock called the Whiteside granite by Keith,[5] occur in the belt and in the region to the west. The mineral composition of this rock, where adjacent to pegmatite bodies, is similar to that of the pegmatite, but simpler, consisting largely of microcline, quartz, and sodic plagioclase. In places the two rocks intergrade. Pegmatite bodies in the vicinity of Kings Mountain form a peripheral zone along the sinuate east side of a large body of the granitic rock (pl. 39). This areal relationship suggests that the pegmatite minerals that are also constituents of the granitic rock probably were derived from the granitic rock or from its source. The pegmatite minerals that are not constituents of the granitic rock may have had a different source.

All of the rocks, including the pegmatite bodies, described below, are cut by dikes of fine-grained diabase, similar to those that have been intruded into Triassic rocks farther east in the Piedmont. The diabase dikes are steeply dipping, tabular bodies, which range in thickness from a few inches to 35 feet, and trend N. 40°-50° W., but two dikes less than 1 foot thick were seen that are parallel to the bedding in weathered micaceous limestone.

Pegmatite

The tin- and spodumene-bearing pegmatite bodies are mostly tabular, of lenticular horizontal section, and of unknown verti-

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5/ Keith, Arthur, op. cit.

cal dimensions. The most regular in outline were emplaced in major joints that strike northwestward across the metamorphic rocks; few of these are more than 25 feet thick or 450 feet long. Other, more numerous, bodies lie parallel to the strike of interlayered country rocks. These are less regular in plan than those in the joints and are larger, attaining a maximum thickness of 395 feet and a maximum length of 3,250 feet. Of the hundreds of pegmatite bodies in the belt, most are less than 10 feet thick, and the smallest are lenslike aggregates of quartz and feldspars less than an inch in length.

The pegmatite of the Carolina belt differs notably from all that seen by the writer elsewhere in the Southern Appalachian region, except the tin-bearing pegmatite of Coosa County, Ala. The pegmatite in both areas consists largely of fine-grained albite and quartz, but the Alabama pegmatite is simpler in mineral composition than that of the Carolinas, and apparently contains no lithium minerals and very little coarse-grained microcline. The pegmatite of the Carolina belt is closely associated with much quartz-muscovite rock termed greisen, some of which contains cassiterite.

Minerals.--The dominant constituents of the pegmatite are fine-grained albite and quartz. The coarse oligoclase which characterizes much of the pegmatite in the Blue Ridge province occurs here only in very small quantity, and muscovite, though generally present, is too fine-grained and scarce to be of commercial value except as a possible minor byproduct. Microcline and spodumene, which are common but rarely dominant, are mostly medium- to coarse-grained. The crystals are characteristically fractured, and are veined with the fine-grained albite and quartz; a few of the smaller crystals of microcline are euhedral, but no euhedral crystal of spodumene was seen during the present study. The maximum observed dimension of microcline is 45 inches. The spodumene crystals are lath-shaped; the maximum

length observed is 38 inches, and the maximum thickness 10.5 inches.

Cassiterite occurs persistently enough to be characteristic, though in general it is not abundant. It is dark brown in color, and is conspicuous among the white and light-colored minerals of the pegmatite. The grains are mostly between 0.5 mm. and 2.0 cm. in maximum diameter. They are angular and fractured and, although they commonly show one or more crystal faces, only two complete crystals are known to have been found. Cassiterite can be confused with only two other pegmatite minerals, columbite-tantalite and ilmenite, but the three can easily be distinguished by their streak alone: that of the cassiterite is light tan to cream-colored, that of columbite-tantalite is chocolate brown, and that of ilmenite is black.

The spodumene offers probably greater commercial possibilities than the cassiterite, particularly if regarded as the chief product in a possible concentration procedure that would yield other pegmatite minerals as byproducts. The possible reserves of recoverable spodumene in two outstanding areas are considered on pages 267-269. Spodumene is distributed unevenly in the pegmatite bodies, but less so than cassiterite. Many of the finer-grained bodies consist predominantly of albite and quartz, and carry little spodumene, but many of the coarser-grained bodies may contain an average of 15 percent or more. Spectrographic analysis of the spodumene [6] has shown the presence of eight minor impurities which are believed to be isomorphous constituents of the mineral. These are listed above in the annotated bibliography (p. 250).

A complete list, in alphabetical order, of the minerals that have been found in the pegmatite bodies during the present study is given on the following page. Minerals listed as hypogene

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6/ Gabriel, Alton; Slavin, Morris; and Carl, H. F., Minor constituents in spodumene: Econ. Geology, vol. 37, p. 119, 1942.

include those that were deposited by igneous emanations from a deep-seated source, together with small amounts of actinolite, hornblende, biotite, clinozoisite, and graphite derived from the wall rocks. The minerals listed as supergene were formed by weathering of the hypogene minerals. Hypogene minerals that apparently are not fairly well disseminated through the pegmatite are indicated by an asterisk.

Hypogene	
Amblygonite†	Scarce.
Apatite	Scarce.
Beryl	Scarce, locally common; mostly resembles quartz.
Cassiterite	Scarce except in shoots.
*Chalcopyrite	Very scarce.
Columbite-tantalite	Scarce.
*Dufrenite	Very scarce.
*Dumortierite	Very scarce.
*Garnet	Scarce.
*Lithiophilite	Very scarce.
*A blue manganese phosphate	Very scarce.
Microcline	Common; locally abundant.
*Molybdenite	Very scarce.
Muscovite	Common; abundant in greisen.
Plagioclases:	
An_0 to An_5	Abundant.
*An_5 to An_{40}	Scarce.
*Pyrite	Scarce.
Pyroxenes:	
*Diopside	Very scarce.
Spodumene	Common; locally abundant.
*Pyrrhotite	Very scarce.
Quartz	Abundant.
*Rutile, tin-bearing	Found as float; very scarce.
*Sphalerite	Scarce.
*Titanite	Very scarce.
*Tourmaline	Scarce.
Supergene	
Halloysite	In seams.
Kaolinite and hydrous mica	Common locally.
Purpurite	Very scarce.
Vivianite	Very scarce.
Fine-grained mixtures of hydrous ferric and calcium-ferric phosphates with hydrous iron and manganese oxides; colors olive green, yellow, brown, black	Common.

† Optical and qualitative chemical determinations indicate a composition near the montebrasite end of the amblygonite-montebrasite series.

Structural control of emplacement.--The pegmatite was emplaced in openings formed by minor rock movements that accompanied or followed the folding of the older rocks. The openings include joints that cross the layering (see pl. 40), openings that follow the layering (see pl. 39), and irregular openings (see pl. 41); those of the first two types are common, those of the last rather scarce.

In areas underlain by almost uniformly competent hornblende-biotite gneisses, pegmatite was emplaced in joints that cut at various angles across the strike of the rocks. One such area, which lies in the Beaverdam Creek drainage area, between Lincolnton and Kings Mountain, is shown in plate 40. The pegmatite bodies here are straight, tabular, and nearly uniform in thickness; some bend abruptly where prominent joints intersect. One body in this area is cut by a thick Triassic diabase dike, and an inclusion of pegmatite was found in the diabase. It seems probable that the diabase dikes were intruded into pre-pegmatite joints, however, for their prevailing trend, N. 40°-60° W., falls within the strike range of three sets of the joints.

In areas where country rocks of contrasting competence alternate in relatively thin layers, most of the pegmatite was emplaced parallel to the strike and dip of the layers. Such an area, immediately southwest of Kings Mountain, is shown in plate 39. The interlayered country rocks here are largely competent hornblende gneisses and incompetent muscovite schists.

Some of the pegmatite bodies on the property of the Ka-Mi-Tin Concentrating Co., 2 miles southeast of Lincolnton, are of the third type: they are extremely irregular in shape and attitude. The bodies prospected by power shovel in the western part of the area shown in plate 41 appear to have been emplaced in irregular fractures that commonly cut across the foliation of muscovite schist but are oriented at random.

Origin.--The minerals of the pegmatite bodies were deposited in the order given below. The order of deposition, which is the same throughout the belt, is also the order of increasing abundance with the exception of the minerals of the first stage and the sulfides of the seventh. There is little or no evidence on which to date some of the minerals, and these are not included in the sequence. The relative ages of the minerals listed are apparent from relative degrees of deformation, and from veining and replacement of earlier by later members. Quartz apparently was deposited during all stages but most abundantly in two.

Stage 1. Tourmaline, beryl, and apatite.
Stage 2. Cassiterite and columbite-tantalite.
Stage 3. Quartz (most of the greisen formed).
Stage 4. Spodumene.
Stage 5. Microcline.
Stage 6. Medium-grained albite (minor alteration of spodumene and microcline to muscovite).
Stage 7. Fine-grained albite and quartz (minor quantities of sulfides and apatite).

The minerals are believed to have been deposited by solutions, along channels that were reopened from time to time by intermittent rock movements. The inferred process of deposition may be outlined as follows:

The minerals of stages 1 and 2 developed in and adjacent to prominent joints and fissures forming deposits of three types: (a) Veins and lenticular masses of compact crystalline tourmaline in gneisses and schists; (b) lodes of disseminated tourmaline crystals in muscovite schist; (c) veins and lodes or disseminations of cassiterite, columbite-tantalite, and probably ilmenite, in muscovite schist, between layers of muscovite schist and hornblende gneiss, and in joints that cut obliquely across hornblende-biotite gneisses.

Many deposits of types a, b, and c were fractured and dislocated by wall-rock movements, and the new openings served as channels for the introduction of the quartz of stage 3, which veined the earlier minerals. Quartz also has partially replaced muscovite schist, into which it commonly grades. The muscovite

left by partial replacement has been coarsened by recrystallization, but remains oriented for the most part parallel to the unsilicified schist. It is in the resulting aggregate of quartz and muscovite, called greisen, that cassiterite of possible commercial grade occurs most commonly. At many places, however, quartz was deposited in schist that contained no earlier cassiterite, and greisen is not uncommonly barren of tin. Rarer and possibly later types of greisen that, in places, contain earlier cassiterite were formed (1) locally in joints in hornblende gneiss, with the muscovite possibly derived from alteration of earlier pegmatite minerals, and (2) as zoned open-space fillings 6 inches or less in width, conformable with muscovite schist and containing muscovite crystals oriented perpendicular to the walls.

Some of the early deposits formed during stages 1, 2, and 3 were not greatly disturbed by later rock movements, and they remained unchanged, or but little changed, in mineral composition. Conversely, the minerals of one or more of the early stages are lacking in pegmatite bodies developed by the deposition of later minerals in channels opened after the early deposits were formed. Most of the pegmatite bodies, however, contain minerals of each stage of deposition, indicating that many lines of weakness were persistent.

Not only quartz but other pegmatite minerals were deposited in fissures and joints, and partially replaced adjacent bodies of country rock as much as 400 feet thick. The paragenetic relations are the same in both environments: each pegmatite mineral that replaced wall rocks did so at the same time that it was being deposited in open joints and fissures. The later pegmatite minerals replaced greater volumes of the country rocks than did those deposited earlier, and are more abundant. Replacement of wall rock occurred most commonly where hornblende gneiss and muscovite schist are interbedded, the muscovite

schist being the more extensively replaced. Minerals that replaced wall rocks were less severely fractured by recurrent rock movements than those deposited in openings, and those in oblique joints somewhat less severely than those in fissures parallel to the bedding.

A relatively fine-grained aggregate of albite and quartz of stage 7 is by far the most abundant replacement product. A similar replacement of country rock by plagioclase has been described by C. S. Ross.[7] Tourmaline, spodumene, microcline, and plagioclase as calcic as An_{40} also replaced the wall rocks. Replacement by these minerals, in various degrees, is abundantly exemplified in the belt. Spodumene and microcline, the coarsest-grained minerals, developed to greater size in open fissures, particularly those parallel to bedding, than in replaced wall rock.

From the order in which the pegmatite minerals were formed it is inferred that the composition of the solutions from which the minerals were deposited changed as the process went on but was comparatively simple at any given stage. The partial replacement of large bodies of country rock indicates that these solutions could not have been viscous; had they been so they could not so intimately have permeated the rocks. They are th[illegible]t to have been aqueous.

TIN DEPOSITS

Deposits with greisen gangue

The cassiterite-bearing bodies of greisen, which are the simplest of the ore bodies in mineral composition, are believed to be relatively undisturbed relics of the early pegmatite

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7/ Ross, C. S., Origin of the copper deposits of the Ducktown type in the southern Appalachian region: U. S. Geol. Survey Prof. Paper 179, pp. 24-25, 71, 1935.

stages. The maximum known thickness of the tin-bearing greisen bodies is 3.5 feet, but the average thickness of 35 of them is only 1 foot. No deposit of this type is exposed for its full length, but apparently none is more than 100 feet long and most of them are less than 50 feet long. The few ore bodies that have been prospected to depths greater than their observed lengths along the surface seem to be shootlike in form, but little is known about their dip or pitch lengths.

Deposits with feldspathic gangue

Tin deposits in which the gangue is dominantly feldspathic pegmatite are less numerous than the greisen deposits, but they generally are larger; the largest dimensions measured or reliably reported are: Thickness, 9 feet; strike length, 275 feet; pitch length, more than 200 feet. Three of the larger deposits of this type, the Jones, Faires, and Ross,[8] have a well-defined pitch, which is probably true of most of the feldspathic as well as of the greisen deposits.

The cassiterite of these deposits apparently was emplaced along lines of weakness sufficiently pronounced to be reopened by subsequent movements of the wall rocks, with accompanying abundant deposition of later pegmatite minerals. Some of the tin deposits remain relatively intact, in and along the margins of pegmatite bodies thus enlarged, but others were so disrupted by the recurrent movements that only small and apparently disconnected parts of them are found in the feldspathic bodies. By a decrease in the abundance of cassiterite, these deposits grade into relatively barren feldspathic pegmatite that contains perhaps 1 to 25 grains of cassiterite in each cubic foot.

8/ See references cited in table 18 for descriptions of these mines when in operation prior to 1907.

Quantity and grade of ore

During the course of the present investigation, 55 tin deposits, most of them poorly exposed, were examined (pl. 38). The locations of 37 others, including some mentioned in published accounts of early mining operations, were established only by float ore; 32 that were reported could not be found. With few exceptions, the 92 known deposits are too widely separated to permit the mining of more than one in a single operation. The maximum thicknesses of deposits in which this dimension could be measured were from 1½ to 6 inches for 21 deposits, from 7 inches to 2 feet for 16 deposits, and from 3 to 4 feet for 4 deposits. Sloan [9] states that the Ross deposit was 9 feet thick near the surface prior to its removal by mining.

The cassiterite content of the ore bodies is very uneven. Assays and mill recoveries have shown that in adjacent deposits, or even within a single deposit, the metallic tin content ranges from a trace to more than 6 percent. Field estimates as high as 10 percent have been made for small parts of ore bodies. There are no geologic indications that the cassiterite content will change materially in grade or mode of occurrence with depth, and this is true also of the associated nonmetallic pegmatite minerals.

Accurate data from which to derive an estimate of ore reserves are lacking. On the basis of the approximate dimensions and general grade of the 55 ore bodies examined, and published information on previous mining (see references listed in table 18), the gross tin content of all the deposits in the area may be as much as 10 tons of metallic tin per foot of depth; this includes at least 7 of the larger deposits that have been mined to depths as great as 175 feet. Most of the deposits are

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9/ Sloan, Earle, op. cit., p. 39.

less than a foot thick, however, and are not minable under ordinary conditions.

Only 18 of the deposits are known to be 1 foot or more thick, and for these the limit of reasonably inexpensive mining is the depth of partly weathered rock above the level of ground water, which is about 50 feet. Seven of these deposits, as mentioned above, have been mined to or below this depth, and one (the Swamp shaft ore body of the Ka-Mi-Tin Concentrating Co., which was under water during the present survey) is in low, marshy ground. The remaining 10 bodies of ore 1 foot or more thick have an average grade of possibly 1.5 percent tin; an average thickness of 3 feet and an average length of 100 feet are assumed, giving a calculated reserve of 12,500 tons of ore, containing 188 tons of metallic tin, to a depth of 50 feet, an average of 0.375 ton of tin per foot of depth in each deposit. The 8 deposits of minable widths that have been mined to or below water level may contain ore of equal or even higher tin content, but the costs of mining would necessarily be much higher.

Placer deposits

The few known placer tin deposits in the belt occur in narrow valleys, near deposits in place; but most of them are less than 10 feet thick and contain only a negligible tonnage of cassiterite. Nothing is known regarding the possible occurrence of cassiterite in larger alluvial deposits farther downstream. Three of the most promising of the placers have been worked on a small scale.

The best known placer deposit is that at the Ross mine (locality 60 on pl. 38, and pl. 42), which yielded an unknown part of the mine's production of 130 tons of concentrates.[10/] Of the original placer deposit, about 2,500 tons of cassiterite-

10/ Sloan, Earle, op. cit., p. 92.

bearing alluvium remains in an area of 25,000 square feet. The remainder of the deposit is probably of low grade. The margin of the deposit is shown in plate 42, which also shows the locations of the original open cut and 121-foot shaft, as well as more recent prospect openings.

A placer deposit, having a surface area of 60,000 square feet [11] adjacent to the Jones mine (locality 23, pl. 38) was prospected in 1903-04, but the results are unknown. Keith [12] states that the Blue Ridge Tin Corporation produced several thousand pounds of concentrates from part of an alluvial area of about 50,000 square feet in the narrow valley immediately south of locality 50, plates 38 and 39.

The three known placers, together with similar small bodies yet to be discovered, might add as much as 100 tons of metallic tin to the reserves. A little additional placer tin might be recovered from the tin-bearing soils, mostly less than 1 foot thick, which cover the weathered bedrock for distances rarely exceeding 300 feet down slope from outcrops of the tin deposits. These shallow soils, which could be removed by scraper, may contain about 50 tons of metallic tin. Very few of the deposits in place, however, are weathered sufficiently to be handled by scrapers.

Summary of deposits

The locations of all deposits examined or reported are shown in plate 38, and available information bearing on geologic and economic features are listed in table 18. Underground workings were not accessible at the time of the survey. A few of these have been described in earlier reports, and references to the descriptions are listed in the table.

11/ Pratt, J. H., and Sterrett, D. B., The tin deposits of the Carolinas: North Carolina Geol. Survey Bull. 19, p. 29, 1904.

12/ Keith, Arthur, and Sterrett, D. B., Tin resources of the Kings Mountain district, N. C. and S. C.: U. S. Geol. Survey Bull. 660, p. 141, 1917.

Atlas prospect shaft.--Early in 1941, at the completion of the present study of the tin deposits, the Atlas Collapsible Tube Co., of Chicago, began prospecting at the old Faires mine near the southern limit of the town of Kings Mountain. A shaft about 30 feet deep was sunk 125 feet northeast of the Faires shaft without encouraging results. Two churn-drill holes approximately 40 feet apart were then drilled about 200 feet N. 15° W. of the Faires shaft. Hole No. 1 was drilled to a depth of 122 feet, and hole No. 2 to a depth of 144 feet. Showings of tin ore were reported from each hole, but No. 2, in which the showings were said to be best at depths of 59, 89 to 104, and 144 feet, was considered the better; a shaft was then sunk adjacent to hole No. 2. The shaft had reached a depth of 125 feet in April 1942, when the management permitted an examination to be made.

The walls of the shaft were boarded up. Crosscuts had been driven from the bottom for 30 feet northwest and 12 feet southeast. Two pegmatite bodies and two layers of greisen, conformable with the foliation in muscovite schist, were exposed in the crosscuts, as shown in figure 28. The larger of the pegmatite bodies is 7 feet thick, and was exposed at the base of the shaft; it is said to have lensed out upward at a depth of 95 feet. The section of this body exposed in the northeast wall of the shaft shows the relative ages of some of the commoner pegmatite minerals. Relatively fine-grained albite and quartz, comprising a lenticular core about 2 feet thick, have invaded a distinctly earlier body composed largely of coarse-grained microcline with some spodumene, quartz, and cassiterite.

The cassiterite was seen only in the microcline-rich rock in the southwest wall of the shaft where the albitic rock has permeated the older mass irregularly, and is not confined to a core. It was obvious that the cassiterite-bearing rock at this point is of commercial grade, averaging possibly as much as 2 percent

of tin, but no cassiterite was seen along the strike in the opposite wall. In order to determine whether or not all of the microcline-rich rock can be regarded as tin ore, a transverse channel sample was taken from the northwest side of the body, in the northeast face.

The pegmatite body exposed in the southeast crosscut is 2 to 4 feet thick, has a layered structure, and consists of fine-grained albite and quartz; a little coarse-grained microcline

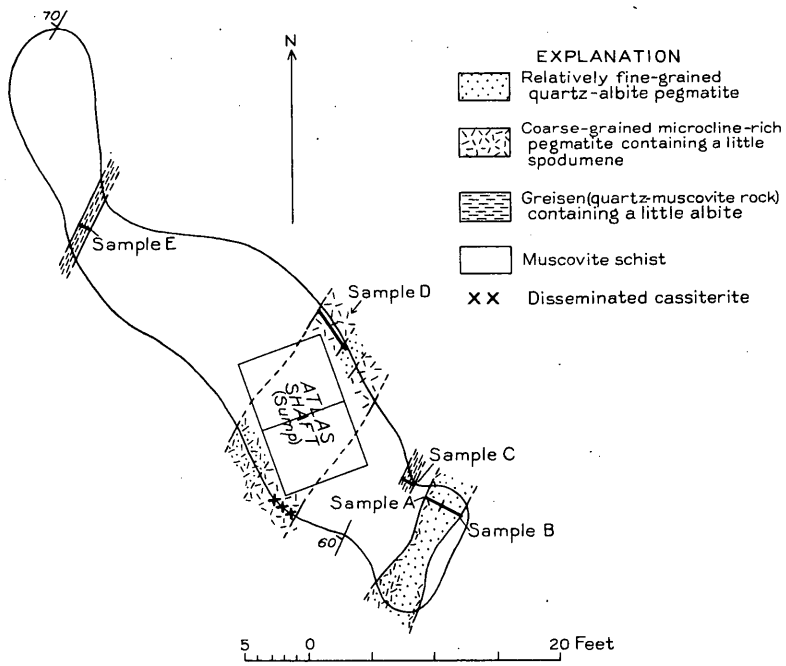

Figure 28.--Plan of crosscut and rocks exposed at base of Atlas shaft, April 1942.

occurs largely, but not entirely, adjacent to the enclosing schist. No cassiterite was visible in this body, but a transverse channel sample was taken from the northwest 14 inches of the body, and another from the southeast 18 inches.

Each of the greisen layers exposed, one in the southeast crosscut, the other in the northwest, is 12 inches thick. Each layer was sampled.

The five samples, assayed by J. G. Fairchild in the chemical laboratory of the Geological Survey, showed less than 0.03 percent of metallic tin in each. It is apparent, therefore, that the only ore of economic grade found in crosscutting four bodies of possible tin-bearing rock, which have an aggregate thickness of 11 feet 8 inches, is in the larger pegmatite, and is exposed only in the southwest wall of the shaft. The continuity of the ore to the southwest of the shaft can be determined only by drifting in that direction.

SPODUMENE RESERVES

The tin-spodumene belt contains an enormous reserve of spodumene, but a steady production in large quantities can be attained only by mining and milling comparatively rich pegmatite that may contain from 10 to 50 percent of spodumene. This might be feasible if a concentration procedure were developed that would yield spodumene as the chief but not the only product. Possible byproduct minerals, for which there are ready markets, include cassiterite, columbite-tantalite, beryl, fine-grained muscovite, feldspars, and possibly amblygonite. All of these except the feldspars are minor constituents where spodumene is most abundant.

In laboratory tests that showed the possibility of making a good separation of spodumene, Norman and Gieseke [13] used rock from the tin-spodumene belt that contained from 33 to 50 percent spodumene. Hess [14] states that hand-cobbed ore mined 1¼ miles southwest of Kings Mountain contained more than 50 percent spodumene. He estimates [15] that the pegmatite bodies of the entire belt may contain an average of 15 percent spodumene. The available information concerning grade is derived, however, from ore

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13/ Norman, James, and Gieseke, E. W., Beneficiation of spodumene rock by froth flotation: Am. Inst. Min. Met. Eng. Tech. Pub. 1161, p. 2, 1940.

14/ Hess, F. L., The spodumene pegmatites of North Carolina: Econ. Geology, vol. 35, p. 965, 1940.

15/ Idem.

that has been taken only from some of the richest outcrops; pegmatite bodies that contain only small, sporadic crystals have apparently escaped general notice. Because of the high proportion of fine-grained bodies that consist largely of albite and quartz, it is neither possible nor practicable to estimate the total amount of spodumene in the belt.

The most favorable showing of spodumene is exposed in a quarry 100 feet long, 12 feet wide, and 35 feet in maximum depth, located 1¼ miles southwest of Kings Mountain. The opening has been made in the east side of a pegmatite body 85 feet thick at this point, and at least 1,450 feet long, but the comparatively rich part exposed in the quarry averages only about 8 feet in thickness. The spodumene crystals here are among the largest in the belt; the maximum length observed was 38 inches. It is reasonable to expect a small quantity of hand-cobbed ore containing as much as 50 percent of spodumene from this quarry, but the large quantity of low-grade rock on the dump shows that only the richest part of the rock exposed is of such grade. The rest of the pegmatite body also contains spodumene, but the average grade is considerably lower than that of the rock in the quarry, and few of the crystals exceed 3 inches in length.

Some of the pegmatite bodies richest in spodumene occur in the two areas shown in plates 39 and 40. Although they constitute only a small portion of the belt, these two areas contain more than 700 pegmatite bodies 1 foot or more thick. The total number in the belt, therefore, must be very large. It is possible to make a rough estimate of the quantity of spodumene ore in these areas, although little is known about the average spodumene content of the pegmatite that could be applied to large tonnages. Comparatively small parts of bodies that may contain as much as 50 percent of spodumene are included because their limits are unknown, and separate estimates cannot be made.

The Beaverdam Creek area, shown in plate 40, contains 388 pegmatite bodies 1 foot or more thick. Spodumene was identified in 245, and about half of these may contain from 10 to 25 percent of spodumene, but probably not more than one-fourth are large enough to be workable. About 60 bodies, therefore, having an average thickness of about 10 feet and an average length of 250 feet, are estimated to contain rock of possible commercial grade. Assuming that not more than half of the material in these bodies would be rich enough to mill, and that this part would yield at least 15 percent of spodumene, it is estimated that the Beaverdam Creek area contains something on the order of 625,000 tons of possible ore, containing about 93,750 tons of recoverable spodumene, to a depth of 100 feet.

The area southwest of Kings Mountain, shown in plate 39, contains 376 pegmatite bodies 1 foot or more thick. Spodumene was identified in 256; it is safe to assume that at least half of these, or 128, include rock that contains from 10 to 25 percent of spodumene, and are thick enough to be quarried. The bodies in this area have a wider range of thickness and length than those in the Beaverdam Creek area, but spodumene is less evenly distributed, so that greater allowance must be made for rock that would not be milled, perhaps not even quarried. It is estimated that the average thickness of the 128 bodies is 35 feet and the average length 540 feet; probably not more than one-fifth of the rock they contain would be workable, and this entire amount probably contains at least 15 percent of spodumene. Using these figures, it is estimated that this sector of the belt contains no less than 3,700,000 tons of possible ore, containing about 555,000 tons of recoverable spodumene, to a depth of 100 feet.

The combined estimate for the two areas is a minimum of nearly 650,000 tons of spodumene in rock that may be minable to

a depth of 100 feet. Boyd [16] gives the following analysis of the spodumene obtained from a hand-sorted sample crushed to minus one-half inch, from which fragments containing visible impurities were rejected:

	Percent		Percent
SiO_2	63.84	K_2O	None
Al_2O_3	28.61	Na_2O	None
Fe_2O_3	.19	Li_2O	7.26
CaO	.04	Ignition loss	.16
MgO	Trace		

It has been found [17] that the amounts of the minor constituents, particularly Fe_2O_3, vary considerably even in a single pegmatite body. Assuming an average of 7 percent LiO_2, the possibly recoverable spodumene estimated above would contain about 45,500 tons of lithia, or more than 20,000 tons of metallic lithium. The two areas to which this estimate applies have a combined length of only 6½ miles out of a total of 24½ miles for the belt. Further, the estimate applies only to the very large quantities of spodumene rock that might be minable for a composite mineral output, rather than to the relatively small bodies of rock that contain from 30 to 50 percent of spodumene.

16/ Boyd, J. E., Jr., Pyrometric properties of spodumene-feldspar mixtures: Am. Ceramic Soc. Jour., vol. 21, p. 386, 1938.

17/ Gabriel, Alton; Slavin, Morris; and Carl, H. F., op. cit., pp. 119-121, 124.

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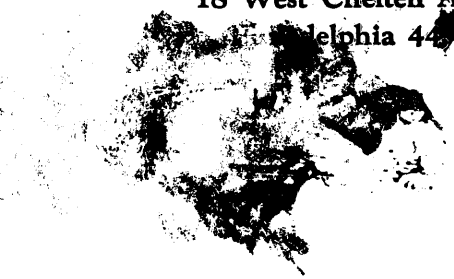

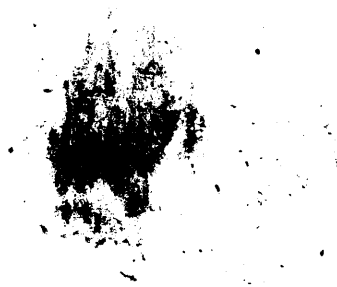

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EXHIBIT 4. (d)-1

DMEW-2841

DMEA 2841

DEFENSE MINERALS ADMINISTRATION
~~WASHINGTON 25, D. C.~~

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Mr. George C. Selfridge, Chairman
Operating Committee - D.M.E.A.
Department of the Interior
Washington 25, D.C.

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

Project Summary Report

By: Michael Ching October 29, 1954

1. Docket No. DMEA-2841 (Columbium-tantalum, beryl, and tin)
Contract No. Idm-E523

Operator - Foote Mineral Company
18 W. Chelten Avenue
Philadelphia, Pennsylvania

Property - Williams Tracts 3 and 4
Cleveland County, North Carolina

Operator's Property Rights - Lease, dated December 10, 1949, from L. M. Williams, et al. Owner's Consent to Lien dated January 16, 1953

2. Contract - Dated May 18, 1953 (Long Form)

Work authorized (as amended)

Agreed unit costs

2,100 ft. diamond drilling @ $7.80/ft. for NX core $7.00/ft. for BX core, and $2.35/ft. for non-core	$16,380.00
2,140 ft. channel sampling @ $0.90/ft.	1,926.00

Estimated actual costs

5 days bulldozing work @ $100/day	500.00
Labor, supervision, consultants	4,400.00
Operating materials, supplies and equipment	890.00
Miscellaneous	6,404.00
Estimated total cost of project	$30,500.00
Government participation at 90 percent	$27,450.00

Amendments -

Amendment No. 1, dated June 19, 1953, changed the number of diamond drill holes from "seven" to "seven or more".

Amendment No. 2, dated July 13, 1953, provided that the work shall begin within 90 days from the date of the contract instead of 60 days.

Amendment No. 3, dated October 30, 1953, extended the contract period from 6 months to 10 months, substituted an Annex I for Article 9 of the contract, increased the estimated costs for labor, supervision, consultants from $3,600.00 to $4,400.00, increased the estimated costs for operating equipment from $180.00 to $540.00, decreased the estimate for contingencies from $1,904.00 to $744.00, and allowed substitution of 1 5/8" diameter core drilling for 2 1/8", where justified, at a reduced unit price.

Amendment No. 4, dated March 1, 1954, allows the use of noncoring roller-bit drilling to start diamond drill holes at a unit price of $2.35/ft.

Amendment No. 5, dated March 3, 1954, extended the contract period from 10 months to 11 months.

Amendment No. 6, dated April 13, 1954, extended the contract period from 11 months to 13 months.

Work completed -

16 diamond drill holes aggregating 2099.6 feet in depth, 1 day of bulldozer trenching and clearing, 422 feet of channel sampling, and 200 samples taken and assayed. The amount of channel sampling on the outcrops was curtailed because of the difficulty of obtaining dependable samples in the deeply weathered pegmatites. Work under the project was started July 28, 1953 and completed May 25, 1954.

3. Final Audit - Dated July 20, 1954

Total cost as billed by contractor	$23,782.62
Exceptions	47.52
Total accepted cost	$23,735.10
Government participation at 90 percent	$21,361.59

4. Certification of Discovery - November 19, 1954

5. Comments - [illegible]

The project was conducted efficiently and in a workmanlike manner by the Operator. His monthly progress reports were satisfactory and his final report was good.

The work was designed to explore a number of pegmatite bodies in the spodumene belt southwest of Kings Mountain, North Carolina, by means of diamond drilling and channel sampling on the outcrops. The drilling and channel sampling were handicapped by the deep weathering of the pegmatites. Because of the limited footage of drilling authorized the objective was confined to obtaining data on the grade of material that might be expected over wide areas. Consequently, it was not possible to delimit even roughly the extent of the various orebodies encountered. An estimate of ore reserves, limited to the immediate vicinity of drill holes and trenches on five pegmatite bodies resulted as follows:

258,400 tons of pegmatite material containing;
441 tons of beryl
15 tons of cassiterite
35 tons of columbite-tantalite
25,450 tons of spodumene

Potential ore reserves were indicated in five other pegmatite bodies.

Additional diamond drilling would be necessary to determine the size and extent of the individual orebodies, and the feasibility of mining operations on the property. Such further work should be left to the Operator.

Michael Ching
Michael Ching

Ellis

☒ Audited

☒ Certified

WORK ANALYSIS SHEET - DMEA PROJECT

Analysis as of 12/9/54
Incl. Voucher for July 1954

☒ Actual Cost

☐ Agreed Unit Costs

Name Foote Mineral Company

Docket No. 2841

State North Carolina

Commodity Columbium, Tantalum, Beryl, Tin

Idm-E No. 523

OPERATION	AUTHORIZED Units	AUTHORIZED Cost	COMPLETED Units	COMPLETED Cost	NET COST
Drifting & Crosscutting					
Raising					
Shafts					
Winzes					
Drilling (Specify) Diamond-NON-core	2100'	23,074.00	2100	19,346.81	19,346.81
Surface Excavation Trenching		1926.00		379.80	379.80
Underground Excavation					
Roads and Trails					
Operating Equipment Purchased					
Surface Rehabilitation & Repairs					
Underground Rehabilitation					
New Building, Improvements, etc.					
Other (Specify) Analyses, Columbium-tantalum (200), Beryllium (200), tin (200)		5500.00		4008.49	4008.49
Totals		$30,500.00		$23,735.10	$23,735.10

Distributed to Authorized drilling

Drilling	$16,380.00
Bulldozing	500.00
Supervision	4560.00
Supplies	350.00
Equipment (rental)	540.00
Contingencies	744.00
	$23,074.00

Prepared by J M Mangelsby

71626

MME Form 7
(10-58)

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Date	Surname	Code
6/21	Murphy	500
6/21	on leave	500
6/21	Talbot	800
	On Leave	120
6/21	Johnson	110
	Franklin	100
		220

JUN 21 1963

Mr. and Mrs. L. M. Williams
P. O. Box 535
Blowing Rock, North Carolina

Re: DMEA-2841 (Columbium-Tantalum, Beryl, Tin)
Foote Mineral Company
Williams Tracts 3 and 4
Cleveland County, North Carolina
Contract Idm-2523

Dear Mr. and Mrs. Williams:

Enclosed is a self-explanatory letter of today to the Operator under the subject contract.

This correspondence relates to the Owner's Consent to Lien executed by you on January 16, 1953, under the Defense Minerals Exploration Administration program.

Sincerely yours,

George Fumich, Jr.

Director

Enclosure

FMMurphy/mm
6/21/63
cc: Director's Reading File
Region IV (2)
Docket
Code 500

Identiaal letters mailed to: Mr. & Mrs. Rube Hatcher
2910 Providence Road,
Charlotte, N.C.

Mr. & Mrs. Robert A. Hovis
2021 Wendover Road
Charlotte, N.C.

Mr. & Mrs. B. B. Culp
Armstrong Circle
Gastonia, N.C.

43683

OFFICIAL FILE COPY
O. M. E
RECEIVED JUN 20 1963

DATE	INITIALS	
6/20		800
6/20		100
6/20		110
6/21	Murphy	500

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF MINERALS EXPLORATION
WASHINGTON 25, D. C.

June 12, 1963

Re: DMEA-2841
(Columbium-Tantalum, Beryl, Tin)
Foote Mineral Company
Williams Tracts 3 and 4
Cleveland County, N.C.
Contract Idm-E523

Foote Mineral Company
18 West Chelten Avenue
Philadelphia 44, Pennsylvania

Gentlemen:

After the completion of the approved exploration work under the contract identified above, we asked to be informed about changes in the status of the property and production from it during the period of royalty obligation.

To assist you to furnish this information and to assure the accuracy of our records, please answer the questions on the back of this letter and return two copies to this office with copies of any pertinent documents.

This is with reference to your letter of March 5, 1957, advising that your mineral lease on the above tracts had been cancelled. The royalty provisions of the referenced contract expired May 18, 1963. To assist us in closing this docket will you kindly fill out and return two copies of this letter.

Sincerely yours,

F M Murphy

F. M. Murphy, Acting Chief
Division of Minerals

MME Form 63
Revised 3-62

REQUEST FOR INFORMATION ON CERTIFIED PROJECT AND PROJECT UNDER ROYALTY AGREEMENT

1. From March 5, 1957, to May 18, 1963 ~~XXXXX~~, has there been a change in ownership, lease, or sublease? If yes, please state details of the transaction below and provide a true or signed copy of the pertinent documents, unless they have been provided before. Yes ☐ No ☐

Our lease on these tracts was cancelled effective January 10, 1957 by 90 days notice to L. M. Williams dated 10/9/56.

2. From March 5, 1957, to May 18, 1963 ~~XXXXX~~, has there been any production from the land subject to the contract? Yes ☐ No ☒

A. If so and it was shipped, give quantity, value, and name and address of purchaser.

Quantity	Value

B. If stockpiled awaiting sale, state quantity, grade, and location.

Type	Quantity		Estimated Grade	Location
Ore		Tons		
Concentrates		Tons		
Other		Tons		

3. Since , has any production been transported through workings (see of contract)? Yes ☐ No ☒

A. If so, state quantity, value, and disposition of material.

Disposition of Material	Quantity	Value

Submitted by: W. M. Raynor

Name W. M. Raynor, Foote Mineral Co. Title Director of Purchasing

Address Route 100, Exton, Penna. Date June 19, 1963

4511

DMEA Form 7
(12-56)

OFFICIAL FILE COPY

Date	Surname	Code
3/27	Ching	700
"	Ellis	700
"	Chambers	800
3/29	Selfridge	130
"	Babcock	110
"	Rothendorf	100
4/1	C	220
		225

APR 1 - 1957

Mr. Robert A. Laurence
Executive Officer
DMEA Field Team, Region V
Room 13, Post Office Building
Knoxville 2, Tennessee

Re: Docket No. DMEA-2841
(Columbium-tantalum, beryl, and tin)
Contract No. Idm-E523
Foote Mineral Company
Williams Tracts 3 and 4
Cleveland County, North Carolina

Dear Mr. Laurence:

In connection with the letter to you, dated March 5, 1957, from the subject Operator, we requested the Associate Solicitor, Division of Mineral Resources, to review the letter and determine the status of the Government's lien on the land following cancellation of the lease.

We were advised as follows: The contract was written on the February 1952 Form MF-200 containing the "abandonment provision" in Article 10. In brief, this provision means that surrender of the leasehold coupled with abandonment of all interest in the land for a period of ten years from the date of the contract, is not a transfer or conveyance of the Operator's interest in the land requiring preservation of the Government's royalty rights. Rather, this provision excuses an operator, to whom it is applicable, from the payment of royalty and also excuses the landlord who has executed an Owner's Consent to Lien. However, should the Operator regain any interest in the land during the ten year period, liability for royalty would resume.

The foregoing interpretation is applicable only where the February 1952 Form MF-200 and Form MF-200A were used without deletion of the "abandonment provision" by amendment or otherwise. The early forms used prior to the February 1952 forms had no such provision nor do the forms revised in June 1954 and subsequently. To avoid possible misapplication of "abandonment provisions," it is suggested that each case of this sort be referred to the Washington Office for interpretation.

MChing/gla (3-25-57)
3-27-57
cc to: Admr.'s Reading File
Operating Committee
THKiilsgaard, 5224
APPROVED: Code 700
Mr. Ching
Contract Adm. & Audit Division

Sincerely yours,

George C. Selfridge

Chairman, Operating Committee (OMB)

O. M. Bishop (OMB)

Member, Geological Survey

(OMB) O. M. Bishop
Member, Bureau of Mines

8623

I have signed this letter, however, I believe it will be very confusing to the field team. It would be far clearer if the field team were applauded only for overturning this decision in the present instance, whereas use of words of present decisions in contracts mention only future. Certainly, in the spirit of majority payment, we can have that in mind in future. The Associate Solicitor's letter is not self explanatory. [memo?]

E. H. Weisgerber,

3/25/57

I agree that the Associate Solicitor's letter is not self explanatory to field personnel who are not familiar with previous actions and changes in contract forms since 1952.

Frank D. Lank

DMEA Form 7
(12-56)

OFFICIAL FILE COPY

Date	Surname	Code
3/25	Ching	700
"	Ellis	700
"	Chamberlin	800
		130
		110
		100
		220

Mr. Robert A. Laurence
Executive Officer
DMEA Field Team, Region V
Room 13, Post Office Building
Knoxville 2, Tennessee

Re: Docket No. DMEA-2841
(Columbium-tantalum, beryl, and tin)
Contract No. Idm-E523
Foote Mineral Company
Williams Tracts 3 and 4
Cleveland County, North Carolina

Dear Mr. Laurence:

In connection with the letter to you, dated March 5, 1957, from the subject Operator, we are enclosing two copies of a memorandum, dated March 22, 1957, to the Administrator from the Associate Solicitor, Division of Mineral Resources, which is self-explanatory.

Sincerely yours,

Chairman, Operating Committee

Enclosures

MChing/gla 3-25-57
cc to: Admr.'s Reading File
Operating Committee
Contract Adm. & Audit Division
T. H. Kiilsgaard, 5224
Code 700
Mr. Ching

APPROVED:

Member, Bureau of Mines

Member, Geological Survey

8623

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SOLICITOR
WASHINGTON 25, D. C.

MAR 22 1957

Memorandum

To: The Administrator, BMEA

From: Associate Solicitor, Division of Mineral Resources

Subject: Docket No. BMEA-1241, Foote Mineral Company (Columbium-Tantalum, Beryl, and Tin), Contract No. Ida-8313

Your memorandum dated March 15, 1957, transmitted a letter dated March 5, 1957, from the subject Operator to the Executive Officer, and requested that we review it and the subject contract to determine whether the Government is entitled to royalty on any future production. The Operator's letter stated there has been no production and that it has "cancelled" its lease (apparently pursuant to paragraph numbered 10 of the lease which granted Operator the right to "terminate").

The contract was written on the February 1951 Form MF-200 containing the "abandonment provision." In brief, this provision means that surrender of the leasehold coupled with abandonment of all interest in the land for a period of ten years from the date of the contract, is not a transfer or conveyance of the Operator's interest in land requiring preservation of the Government's royalty rights. Rather, this provision excuses an operator, to whom it is applicable, from the payment of royalty and also excuses the landlord who has executed an Owner's Consent to Lien (see our memorandum to you dated July 27, 1954, on the subject "Liability of Landlord for Royalties after Abandonment by Lessee-Operator").

On the other hand, should the Operator regain any interest in the land during the ten-year period, liability for royalty would resume.

HCRubin/cmd
Copy to: Solicitor's Docket (2)
BMEA Docket
J. L. Chambers
G. C. Selfridge
E. W. Ellis
R. P. Dwyer
H. C. Rubin
chron.

Robert P. Dwyer

DMEA Form 7
(12-56)

700

OFFICIAL FILE COPY

Date	Surname	Code
3/15	Ching	700
3/15	Ellis	700
3-15	Chambers	800
"	Johnson	110
3/16	Gellings	120
3/18	Mittendorf	200
		220

March 15, 1957

Memorandum

Noted.

To: Associate Solicitor, Division of Mineral Resources

From: The Administrator, DMEA

Subject: Docket No. DMEA-2841
(Columbium-tantalum, beryl, and tin)
Contract No. Idm-E523
Foote Mineral Company
Williams Tracts 3 and 4
Cleveland County, North Carolina

Will you kindly review the letter, dated March 5, 1957, from Foote Mineral Company, and the subject contract, and determine whether or not the Government's lien on the land is still good. It is presumed that the land now reverts back to the owners and that we should now look to them for payment of royalties in case there is production. If you believe that the owners should be so advised, please have the necessary letter prepared.

C. O. Mittendorf (fw)

Administrator

MChing/izm 3-15-57
cc to: Mr. Ching
Admr.'s Reading File
Code 700

8623

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

March 5, 1957.

Mr. Robert A. Laurence, Executive Officer,
DMEA Field Team,
Region VII,
Room 13, Post Office Building
Knoxville 2, Tennessee

Re: DMEA-2841, Idm-E523

Dear Mr. Laurence:

We wish to notify you that the mineral lease between Foote Mineral Company and Williams, Cole, et al, covering the area under the Exploration Project Contract, has been cancelled by Foote Mineral Company, effective January 10, 1957.

Since the exploration program was conducted, there has been no mineral production from the tract. Therefore, no royalty payments are due.

Very truly yours,

FOOTE MINERAL COMPANY

Ernest G. Enck
Secretary

EGE:mmt

OFFICIAL FILE COPY
D M E A
RECEIVED MAR 11 1957

DATE	INITIALS	CODE
3/11	C	220
3/12		800
		225

RECEIVED
MAR 7 - 1957
U. S. Geological Survey
Geologic Division
Knoxville, Tenn.

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.
ROOM 13 POST OFFICE BLDG.
KNOXVILLE 2, TENN.

December 3, 1954

This letter mailed to each of the individuals who signed the Owner's Consent to Lien for exploration contract, DMEA-2841, Idm-E 523.

Enclosed is a copy of the certificate of discovery resulting from exploration conducted jointly by Foote Mineral Company and the Government on land leased by Foote Mineral Company. As a co-owner, you were one of the eight signers of an Owner's Consent to Lien dated January 6, 1953.

Very truly yours,

Robert A. Laurence
Executive Officer
DMEA Field Team, Region VII

RAL/mg
cc - Beck
Lynch
Files
Finance Office
Operating Committee - 2 copies

Operating Committee
2 copies

COPY
mg 12/3/54

FOOTE MINERAL COMPANY
18 West Chelten Avenue, Philadelphia 44, Pa.

December 1, 1954.

Mr. Robert A. Laurence, Executive Officer
DMEA Region VII
United States Department of the Interior
Defense Minerals Exploration Administration
Post Office Bldg.
Knoxville 2, Tenn.

DMEA-2841, Idm-E 523

Dear Mr. Laurence:

We have your letter of November 24th addressed to Mr. Thomas Kesler at Kings Mountain, North Carolina on the above subject.

I am listing below the addresses of the individuals who signed the Owner's Consent to Lien for exploration contract, DMEA-2841, Idm-E 523.

L. M. Williams	P. O. Box 535, Blowing Rock, N. C.
Lena B. Williams	P. O. Box 535, Blowing Rock, N. C.
Jean Cole Hatcher	2910 Providence Road, Charlotte, N. C.
Rube Hatcher	2910 Providence Road, Charlotte, N. C.
Emily Cole Hovis	2021 Wendover Road, Charlotte, N. C.
Robert A. Hovis	2021 Wendover Road, Charlotte, N. C.
Frances Cole Culp	Gastonia, N. C. Armstrong Circle
B. B. Culp	Gastonia, N. C. " "

MG

Very truly yours,

FOOTE MINERAL COMPANY

/s/ Ernest G. Enck

EGE:mmt

Ernest G. Enck
Secretary

cc. Mr. T. L. Kesler
Foote Mineral Company
Kings Mountain, N. C.

urname copy

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

Ching
Ellis
Chamberlin
Newcomb
Hedges
Selfridge
Kipman

Mr. Louis G. Ellis
Vice President - Sales
Foote Mineral Company
18 W. Chelten Avenue
Philadelphia, Pennsylvania

NOV 22 1954

INTERIOR DEPT.
NOV 9 - 1954
SOLICITOR

Re: Docket No. DMEA-2841
(Columbium-tantalum, beryl, and tin)
Contract No. Idm-2523
Williams Tracts 3 and 4
Cleveland County, North Carolina

Dear Mr. Ellis:

Enclosed is a "Certification by the United States of America of a Discovery or Development Under an Exploration Project Contract." This certification covers all the land described in Article 2 of the above-described contract.

By the terms of the Exploration Project Contract, as amended, and of the certification, all columbium-tantalum, beryl, tin, and other valuable minerals produced from the land described in Article 2 of the contract, from May 18, 1953, the date of the contract, are subject to the Government's percentage royalty as set forth in the contract until the sum of $21,361.59 is paid, or until May 18, 1963, whichever occurs first.

Payments should be made to Mr. Robert A. Laurence, Executive Officer, DMEA Field Team, Region VII, Room 13, Post Office Building, Knoxville 2, Tennessee. Checks should be payable to the Defense Minerals Exploration Administration. The purchaser should be advised to deduct the royalties from the amount due on each shipment and forward the check directly to the Executive Officer. Royalty payments to the Government should be accompanied by suitable evidence, such as copies of settlement sheets, showing quantity and grade of the products sold, the name of the purchaser, and the price and charges, certified to be correct by the purchaser.

You are requested to notify Mr. Laurence of any changes in ownership or production rights that might have any effect on the Government's right to its percentage royalty. Also, if production

R.C.L.

ceases at any time for an extended period, please notify Mr. Laurence at six-month intervals that no production has been made, when that is the case.

Sincerely yours,

C. O. Mittendorf

Administrator

Enclosure

MChing/gla
11-8-54
cc to: Admr.'s Reading File
Operating Committee
Mr. J. H. Hedges, Rm. 4604
Mr. Kiilsgaard, Rm. 5224
Field Team, Region VII (2) with 8 extra copies to be forwarded to owners
Docket
Code 700
Mr. F. E. Johnson
Mr. Ching

Surname copy

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

Ching
Ellis
Chamberlin
Newcomb
Hedges
Selfridge
Kilpatrick

NOV 22 1954

Mr. Irving Gumbel, Acting Director
Materials Division
Emergency Procurement Service
General Services Administration Bldg., Room 5002,
7th and D Streets, S. W.
Washington 25, D. C.

Re: Docket No. DMEA-2641
(Columbium-tantalum, beryl, and tin)
Contract No. Idm-8523
Foote Mineral Company
Williams Tracts 3 and 4
Cleveland County, North Carolina

Dear Mr. Gumbel:

I am enclosing one copy of a certification of discovery or development relating to the subject exploration contract.

The contract, dated May 18, 1953, covers a project estimated to cost $30,500.00. Work under the project was started July 28, 1953, and completed May 25, 1954. The final audit shows total expenditures during the life of the contract were $23,735.10, with Government participation amounting to $21,361.59, or 90 per cent.

The contract, as amended, provides for 2,100 feet of diamond core drilling, bulldozer clearing and trenching, and 2,140 feet of channel sampling on the outcrops of pegmatite dikes in the spodumene belt southwest of Kings Mountain, North Carolina.

The work completed consisted of 16 diamond drill holes aggregating 2099.6 feet in depth, some bulldozer trenching and clearing, and 422 feet of channel sampling. The amount of channel sampling on the outcrops was curtailed because of the difficulty of obtaining dependable samples in the deeply weathered pegmatites.

Since the purpose of the exploration was to obtain data on the grade of material that might be expected over wide areas, it was not possible to delimit even roughly the extent of the various ore bodies encountered. An estimate of ore reserves, limited to the immediate vicinity of drill holes and trenches on five pegmatite bodies, resulted as follows: 258,400 tons of pegmatite material containing 441 tons of beryl, 15 tons of cassiterite, 35 tons of columbite-tantalite, and 25,450 tons of spodumene.

R.G.G.

The work proved the existence of sufficient ore grade material on the property to justify a certification of discovery or development.

Sincerely yours,

C. O. Mittendorf (for)

Administrator

Enclosure

MChing/gla
11-8-54
cc to: Admr. Reading File
Operating Committee
Docket ✓
Messrs. J. H. Hedges, Rm. 4604
T. H. Kiilsgaard, Rm. 5224
F. E. Johnson
Code 700
Mr. Ching
DMEA Field Team, Region VII (2)

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

Ching
Ellis
Chandler
Selfridge
Johnson

NOV 22 1954

Mr. Robert A. Laurence
Executive Officer
DMEA Field Team, Region VII
Room 13, Post Office Building
Knoxville 2, Tennessee

Re: Docket No. DMEA-2641
(Columbium-tantalum, beryl, and tin)
Contract No. Idm-8523
Foote Mineral Company
Williams Tracts 3 and 4
Cleveland County, North Carolina

Dear Mr. Laurence:

Enclosed for your files are two copies each of a certification of discovery or development issued on the subject property and the covering letter to the Operator.

With respect to the Special Notice in the Operating Committee's minutes of October 29, 1954 (No. 435), we find that the addresses of the eight owners have not been supplied this office. We are, therefore, attaching eight additional copies of the certification and of the covering letter to the Operator for transmittal to the various owners.

Sincerely yours,

George C. Selfridge
by ESS

Chairman, Operating Committee

Enclosures 20

J. H. Hedges by ESS
Member, Bureau of Mines

W. L. Newcomb by ESS
Member, Geological Survey

MChing/gla
11-8-54
cc to: Admr.'s Reading File
Operating Committee
Docket
Messrs. J. H. Hedges, Rm. 4604
T. H. Kiilsgaard, Rm. 5224
Code 700
Mr. Ching

R.C.G.

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

Minerals Administration
RECEIVED
NOV 8 1954

November 8, 1954

Re: DMEA-2841
Foote Mineral Co.
(Tracts 3 & 4)
Cleveland Co., N.C.
Columbium-Tantalum,
Beryl, Tin

Memorandum

To: E. W. Ellis, Defense Minerals Exploration Administration

From: E. L. Newcomb, U. S. Geological Survey

Subject: Review of Final Field Team report

The completed work included 2099.6 feet of diamond drilling and 422 feet of channel samples.

Indicated reserves are 258,400 tons of pegmatite material containing 440.8 tons of beryl, 14.9 tons of cassiterite, 34.55 tons of columbite-tantalite and 24,450 tons of spodumene.

The Field Team has recommended a certificate of discovery be issued.

The objectives of the exploration have been tested, however further drilling will be needed before exploitation can be undertaken by the operator.

Although the Field Team Final report is rather brief, the thoroughness of the operator's Final report left little to be added by the Field Team in their review of the project results.

A certificate of discovery should be issued.

E. L. Newcomb

E. L. Newcomb

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
~~WASHINGTON 25, D. C.~~
Room 13, Post Office Building
Knoxville 2, Tennessee

U. S. DEPT. OF THE INTERIOR
Minerals Administration
RECEIVED
OCT 19 1954

October 18, 1954

Memorandum

To: Operating Committee, DMEA - Washington, D. C.

From: Field Team, DMEA, Region VII

Subject: Field Team Final Report on DMEA-2841, Contract Idm-E523 (Columbium-Tantalum, Beryl and Tin)
Foote Mineral Company, Cleveland County, North Carolina

Enclosed are the original and three copies of the subject report. The Field Team is in agreement with the report and recommend that a certification of discovery be made.

Robert A. Laurence
Robert A. Laurence
Executive Officer

Wm. A. Beck
Wm. A. Beck, for V. J. Lynch
U. S. Bureau of Mines

Enclosures 4

FINAL F.T. REPORT

Reviewed by
DMEA OPERATING COMMITTEE
10-22-54
(date)

UNITED STATES
DEPARTMENT OF THE INTERIOR

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
OCT 19 1954

DEFENSE MINERALS EXPLORATION ADMINISTRATION

FINAL REPORT

FIELD TEAM, REGION VII

on

DMEA Docket 2841, Contract Idm-E523

(Columbium-Tantalum, Beryl and Tin)

FOOTE MINERAL COMPANY, 18 W. CHELTEN AVE., PHILADELPHIA, PA.

Pegmatite near Kings Mountain, Cleveland County, N. C.

By

B. F. Buie, Geologist (WAE)
U. S. Geological Survey

September 30, 1954

Reviewed by
DMEA OPERATIONS [illegible]
10-22-54
(date)

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
OCT 19 1954

FINAL REPORT

DMEA Docket No. 2841, Contract No. Idm-E523
(Columbium-Tantalum, Beryl, and Tin)

Foote Mineral Co., 18 W. Chelten Ave., Philadelphia, Pa.

Pegmatite near Kings Mountain, Cleveland County, N. C.

The exploration herein referred to was conducted under Contract Idm-E523 dated May 18, 1953, with Amendments 1 through 6, the last dated April 13, 1954. The completion date of the contract was June 18, 1954. Work was begun July 28, 1953 and completed May 25, 1954. The property where the exploration was performed is known as Tract No. 3 and Tract No. 4 of Foote Mineral Company leases, about four miles southwest of the town of Kings Mountain, N. C. The location and boundaries of the two tracts are shown on the map, Exhibit B, attached to the Contract.

Estimate of Reserves. The Operator's estimate of reserves, which is acceptable as an estimate of indicated reserves, is:

258,400 tons of pegmatite, in five bodies, containing:
- 440.8 tons of beryl
- 14.9 tons of cassiterite
- 34.55 tons of columbite-tantalite
- 25,450 tons of spodumene

At the time of the first inspection of the project by the DMEA Field Team agreement was made with the Operator's representative that emphasis should be placed upon exploration rather than upon the blocking out of ore. Accordingly, the data obtained will permit reserves to be estimated only very roughly. It is noted that the Operator's estimate of reserves does not include any reserves in Tract No. 4. Presumably this is because of the lack of evidence of regularity in the shape of the pegmatite bodies in this tract. However, the pegmatite penetrated by Hole 4-3-1 contains a sufficiently high percentage of spodumene to be minable if the body is large enough. Even though the drilling in Tract No. 4 did not result in establishing calculatable reserves, it did result in a discovery under the terms of the Contract.

Recommendations.

1. Additional core drilling is warranted, and will have to be done before the deposits can be mined intelligently. The drill holes will be necessary to determine more accurately the size and extent of the individual pegmatite bodies. This drilling should be done at the Operator's expense without Government participation.

2. DMEA should certify that the project was successful and that the Government is entitled to royalties from production from any of the pegmatite bodies in Tract 3 or Tract 4.

Recommendations, Cont'd.

3. Production appears to be economically feasible from at least the near-surface portions of the spodumene-bearing pegmatites.

Summary of Operations. The exploratory work included 2099.6 feet of drilling, and 422 feet of trenching (channeling). Assays were run on a total of 200 samples, 121 of these being from drill cores, 40 from drill sludge, and 39 from trenching. The place and interval from which each sample was taken is shown in the Operator's final report. Assays were made in the laboratories of the Operator. Constituents determined were columbium-tantalum, beryllium, tin and lithium. Assays for lithium were paid for by the Operator without Government participation. The project was conducted by the Operator efficiently, expertly, and in a workmanlike manner, in accordance with the terms of the contract. Recovery of core and sludge was unsatisfactory during the early stage of the work, largely because of the weathered condition of the rock, but recovery was much improved after the first three holes.

Description of the Deposits. The deposits are adequately described in the Operator's final report, with the exception that the tabulation on page 6 does not mention the occurrence of weathered pegmatite from depth of 8 feet to 17.6 feet in Hole 4-2-1, and the chart "Exhibit No. 3" does not show the occurrence of weathered pegmatite from 20.9 feet to 26.3 feet in Hole 4-3-1. Detailed logs of the drill holes were submitted in the Operator's monthly reports. The Operator's reports, including maps, sections, and assay data, are acceptable.

Expenditures.

Total approved	$30,500.00	
Total cost of project	~~25,274.13~~	23,735.10
Government's share of cost	~~22,746.72~~	21,361.59
Government's share unexpended	~~4,073.28~~	6,088.41
Value of production during operations	none	

Equipment. The only equipment purchased with funds in which the Government participated consisted of expendable items; $100 for small tools and $219.75 for core boxes. It is expected that these items will be left with the Operator, as the expense of offering them at sale would exceed the small salvage value.

B. F. Buie.

B. F. Buie, Geologist (WAE)
U. S. Geological Survey.

September 30, 1954

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
~~WASHINGTON 25, D.C.~~
ROOM POST OFFICE BLDG.
KNOXVILLE 2, TENN.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
SEP 30 1954

September 28, 1954

REGISTERED MAIL

Memorandum

To: Operating Committee, DMEA- Washington

From: Executive Officer, DMEA - Region VII - Knoxville, Tenn

Subject: Operators Final Report, DMEA-2841, Idm-E 523. King Mountain Area. (Columbium, tantalum, beryl, tin) Foote Mineral Co. Philadelphia, Pa.

Enclosed herewith are four copies of the Operator's final report on the subject exploration contract. These were received in this office in June, and have been held here during preparation of the Field Team final report. We hope to be able to forward the Field Team final report in the near future.

The project was successful, in that reserves of spodumene and three by-product strategic minerals were delineated. Therefore, we expect to recommend certification. This will be confirmed as soon as we receive the geologist's final report and his comments on the Operator's reserve figures.

Robert A. Laurence
Robert A. Laurence

OPR'S FINAL REPORT

see packet for Exhibits 1-10

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
SEP 30 1954

FINAL REPORT ON D. M. E. A. EXPLORATION PROGRAM OF FOOTE MINERAL COMPANY

(D. M. E. A. Docket 2841, Contract IDM - E 523

Foote Mineral Company
18 W. Chelten Avenue
Philadelphia 44, Pennsylvania

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EXHIBITS

1. Geologic map of part of the tin-spodumene belt southwest of Kings Mountain, N. C., showing location of Tracts 3 and 4 of Foote Mineral Company.

2. Exploration area in Tract 4.

3. Columnar sections of drill holes in Tract 4.

4. Exploration area in Tract 3.

5. Plan and sections showing exploration of Pegmatites 3-4, 3-5, and 3-6.

6. Plan and section showing exploration of Pegmatite 3-1 and north end of Pegmatite 3-2.

7. Plan and section showing exploration of middle part of Pegmatite 3-2.

8. Plan and section showing exploration of Pegmatites 3-3 and 3-7.

9. Tables showing (a) assays of all core, sludge, and trench samples, and (b) footage distribution of pegmatite in all drill holes.

10. Mineral content of pegmatites computed from assays.

Defense Minerals Administration
RECEIVED
SEP 30 1954

INTRODUCTION

The contract on which this work is based became effective May 18, 1953, and extends, with amendments, to June 18, 1954. It provides for maxima of 2,100 feet of diamond core drilling and 2,140 feet of channel sampling, which is termed trench sampling in this report. Other provisions are for supervision, bulldozing, supplies, trucking, accounting, and assays, all of which are set forth in detail in the contract and its six amendments.

Dr. B. F. Buie was assigned from the D. M. E. A. Field Team, Region VII, to inspect and approve the work on the part of the government. Operations on the part of Foote Mineral Company were directed by T. L. Kesler and actively prosecuted by W. E. Dill, Jr. W. A. Beck of Region VII also visited the project on several occasions. All contacts were characterized by a strong spirit of cooperation, a feature that was particularly desirable in view of special difficulties encountered.

These difficulties, which influenced both the planning and execution of the work, were: (1) the large size of the tracts in proportion to the prospecting footages allowed; (2) rotten conditions in the zone of weathering, adversely affecting water circulation in spite of much cementing of the drill holes; and (3) the impossibility of obtaining dependable trench samples in pegmatite too deeply weathered to provide bold outcrops.

After thorough discussion of these features by government and company representatives, the following procedure was agreed

upon. (1) Prospecting would be spread widely in order to yield best results on the distribution of columbite-tantalite, beryl, and cassiterite, but with corresponding loss of the close control that would be necessary to block out ore. (2) The use of BX in addition to NX drilling was allowed in order to case off the most weathered ground and restore water circulation; but this allowance did not come until the work in Tract 4 and part of that on Pegmatites 3-4 and 3-5 in Tract 3 had been finished. (3) Trenching, or channel sampling, would be confined to outcrops sufficiently fresh to have normal weight and mineral content.

OCCURRENCE OF THE PEGMATITE

The pegmatites explored are in Tracts 3 and 4 of Foote Mineral Company, about four miles southwest of Kings Mountain, N. C. The tracts are in the tin-spodumene belt of the Carolinas, which is described in U. S. G. S. Bull. 936-J. Exhibit No. 1 of this report is a photostatic copy of Plate 39 of the bulletin, with Tracts 3 and 4 added. It also shows by number the pegmatites that were explored.

The pegmatites penetrated by the drill holes range from mere stringers to a maximum of about 40 feet with the exception of Pegmatite 3-7, whose size and shape cannot be predicted. Their strike is northeast, approximately parallel to that of interlayered mica schist and amphibolite, which make up the country rocks. These rocks dip steeply northwest, and the Pegmatites tend to dip in the same direction although with

numerous irregularities and with much pinching and swelling. In the main, the form shown by the outcrops cannot be expected to remain uniform to any appreciable depth.

MINERAL COMPOSITION

Common Minerals

Listed in their order of abundance, the common minerals of the pegmatites are feldspar (albite and microcline), quartz, spodumene, and muscovite. Most of the albite and quartz is of medium to very fine grain size. The muscovite is not much coarser than that recovered from most scrap-mica mining. The spodumene and microcline are very coarse, ranging up to three feet long in some pegmatites elsewhere in the belt.

Uncommon and Rare Minerals

A full list of the scarcer minerals that have been identified to date in the pegmatites of the tin-spodumene belt is contained in Bull. 936-J. Of these, amblygonite is known to be somewhat generally distributed, but is not known how evenly or in what specific amounts. Columbite-tantalite, beryl, and cassiterite are also present, and are the basis for the program described in this report. The beryl occurs in very small crystals, and so closely resembles quartz that it is rarely recognized. The columbite-tantalite and cassiterite ~~is~~ are disseminated in sporadic grains, and also occur~~s~~ in greater abundance in a very few narrow lenses in or along the sides of the pegmatites.

EXPLORATION UNDER CONTRACT IDM - E 523

Core Drilling

The contract first called only for NX size core, but in spite of repeated cementing, the holes failed to give enough water return to avoid choking, and BX size was later permitted so that a second string of casing could be used. This permitted deeper drilling, but penetrating the upper part of the zone of weathering remained a problem. Every effort was made to obtain sludge samples, but open seams and high porosity in the zone of weathering prevented the recovery of cuttings by reducing or cutting off water circulation. Even after casing was set in such ground, random crevices and rotten zones at greater depth prevented complete flushing of the holes.

The sludge samples that were recovered were dried, weighed, and compared with the theoretical weights to be expected from full recovery. The results were so disappointing that Foote Mineral Company has no confidence in the sludge samples, although they have been assayed with values as shown in Exhibits 9 and 10. Pegmatite core was sampled in 5-ft. intervals, or nearest practicable length, and the sludge was similarly sampled as far as possible.

All cores were inspected by the government before sampling, and the sampling method was approved. The whole pegmatite core was crushed for assay samples to eliminate inequalities that might result from splitting cores of such coarse-grained rock.

Logs of the drill holes have been submitted in detail with the monthly reports, and are not repeated here. The distribution of pegmatite, however is shown in the columnar and cross sections and in tabular form in Exhibit 9.

Core recovery was unusually good for a deeply weathered environment, and is shown in the following table:

Drill Hole	Total Coring (% Recovery)	Pegmatite Cored (% Recovery)
4-1-1	3	None encountered
4-1-2	75	None encountered
4-2-1	37	None encountered
4-3-1	77	74
4-3-2	81	90
4-1-3	69	80
3-4-1	74	91
3-4-2	98	98
3-5-1	99	91
3-5-2	88	91
3-6-1	76	95
3-2-1	97	100
3-1-1	77	100
3-2-2	96	100
3-3-1	97	98
37-1	92	83

Trenching

Eight trenches or channels were sampled in the present work. Their location is shown in Exhibit 4, and the plan of sampling in Exhibits 5, 6, 7, and 8. The intervals here were 10 feet or nearest practicable length except in Pegmatite 3-3, which was found to consist only of five thin stringers. This trench made it evident that further trenching should be limited to well exposed pegmatite of appreciable thickness. It was further limited to bodies in which core-drill holes were successfully completed.

Assaying

After being crushed and quartered down, all samples for assay were shipped to the laboratory of Foote Mineral Company, at Exton, Pennsylvania. Assays were run spectrographically under the direction of A. B. Chandler. In assaying for tin, wet chemical checks were run by various outside laboratories to assure standardization of method. Assays for columbium and tantalum were made according to a method developed by A. B. Chandler and R. H. Dolan, soon to be published. Results of the assays are listed in Exhibit 9, and were computed at Kings Mountain in terms of minerals, as shown in Exhibit 10. Duplicate samples were delivered to D. M. E. A., and duplicates were also held in reserve in case of losses in shipment.

In Exhibit 10, the computed mineral values of core and trench samples (excepting trench 3-3-T1, which encountered only

five thin stringers) are weighted for each pegmatite of possible mining width. The assays listed as "less than" minima in Exhibit 9 are shown by the star symbol in Exhibit 10, and, in weighting, are considered zero value. Corresponding values of the sludge samples are not weighted, because of the poor and erratic weight recovery of sludge, as described above. It is believed that the core and trench samples accurately indicate grade, but that the sludge would distort the picture, and the distortion would not even be systematic.

RESULTS OF THE EXPLORATORY WORK

General Range in Grade of Pegmatite

Exhibits 9 and 10 show the variations in chemical and mineral grade among the pegmatites explored, which are as follows:

Beryl ranges from traces to 1.08 percent, with most values between 0.20 and 0.30 percent;

Cassiterite ranges from traces to 0.1733 percent, with many values lower than 0.005 percent;

Columbite-Tantalite ranges from traces to 0.0927 percent, with most values lower than 0.03 percent;

Spodumene ranges from nil to 36.99 percent. As for mineral associations, it appears that pegmatite containing no spodumene has very little beryl and cassiterite, but may contain as much columbite-tantalite as does pegmatite with spodumene.

Reserves Adjacent to Drill Holes and Trenches

As the purpose of the exploration was to obtain data on grade over wide areas, the opportunity to block out proved tonnages of ore was correspondingly reduced. The only estimates of blocked ore that can be made are limited to the immediate vicinity of drill holes and trenches, and, further, to localities where the work proved up simple rather than complex form of the bodies.

In this manner, only parts of the prospected pegmatites may be estimated, as outlined in the following sections of the report. In the remainder of these bodies, and in the other pegmatites shown in Exhibits 1 and 4, there is undoubtedly a total reserve that is many times the sum of the small blocks described herein, for which there is definite control.

Pegmatite 3-1

Drill holes 3-2-1 and 3-1-1 were drilled to intersect Pegmatite 3-1 and an apparent zone of pegmatite lenses termed Pegmatite 3-2 at the surface. Exhibit 6 shows that hole 3-2-1 penetrated a pegmatite apparently equivalent to the outcrop of Pegmatite 3-1, but hole 3-1-1 failed to find pegmatite at a corresponding depth. Instead, it penetrated a zone of fractured and contorted country rock at equivalent depth. Consequently, the reserve indicated in Pegmatite 3-1 must be limited to half the depth to hole 3-1-1, or 30 feet. The surface area extends 50 feet beyond trenches 3-1-T1 and 3-1-T3. The volume is 360,000 cubic feet. At 11.7 cubic feet per ton, the block weighs 30,800

tons, and contains 61.6 tons of beryl, 2.3 tons of cassiterite, 3.01 tons of columbite-tantalite, and 5,250 tons of spodumene.

Pegmatite 3-2

Hole 3-2-1 showed no minable ore in this body, but hole 3-2-2 and trench 3-2-T1 indicate a block extending 50 feet along the strike in both directions away from the trench. To the median depth of the pegmatite in hole 3-2-1, a block of 160,000 cubic feet or 13,600 tons is thus blocked. It contains 34 tons of beryl, 0.3 tons of cassiterite, 3.04 tons of columbite-tantalite, and 1,650 tons of spodumene.

Pegmatite 3-3

Exhibit 8 shows that this body consists of two parts as penetrated by holes 3-3-1 and 3-7-1. To the median depth of each part in hole 3-7-1, the combined block has a volume of 1,130,000 cubic feet, and a combined weight of 96,500 tons. It contains 70.9 tons of beryl, only a trace of cassiterite, 3 tons of columbite-tantalite, and 2,400 tons of spodumene.

Pegmatite 3-5

Exhibit 5 shows a reserve block in this pegmatite, controlled by vertical hole 3-5-1 and inclined hole 3-5-2 in addition to three trenches. The block is 300 feet long, extending 50 feet beyond trenches 3-5-T1 and 3-5-T3, and inclined depth of 80 feet extending from median points in the outcrop and in Hole 3-5-1. The block thus amounts to 1,045,000 cubic feet, or 88,500 tons. It contains 274.3 tons of beryl, 12.1

tons of cassiterite, 20.2 tons of columbite-tantalite, and 16,150 tons of spodumene.

Pegmatite 3-7

Exhibit 8 shows that inclined hole 3-7-1 passed through the eastern edge of a pegmatite having a very irregular outline, and possible a considerable extent to the west. Neither the outcrop nor the core contains spodumene, this pegmatite being the ordinary microcline type. A poorly controlled block between the drill hole and the surface, and extending 50 feet in each direction away from the cross section, contains 340,000 cubic feet, or 29,000 tons, of pegmatite. The block contains only a trace of beryl, 0.2 ton of cassiterite, 5.3 tons of columbite-tantalite, and no spodumene.

CONCLUSIONS

The exploration program has yielded two types of information of value. One of these relates to the proved reserve, in five relatively small blocks of pegmatite, of 440.8 tons of beryl, 14.9 tons of cassiterite, 34.55 tons of columbite-tantalite, and 25,450 tons of spodumene. Together, these five blocks constitute only a small part of the pegmatite available in Tracts 3 and 4.

The more important information relates to the requirements of crude pegmatite to produce a ton of the three rare minerals

on which the program was focussed. There are wide and unsystematic variations in grade, but, in general, about 520 tons of crude ore are required per ton of beryl, about 10,700 tons per ton of cassiterite, and about 7,500 tons per ton of columbite-tantalite.

Exploration Department,
Foote Mineral Company,
Kings Mountain, N. C.
May 25, 1954

August 3, 1956

Memorandum

To: J. L. Chambers, Chief, Contract Administration & Audit Br.

From: Executive Officer, NMEA - Region VII

Subject: NMEA-6541, Lease 55, Kerr Mineral Company-Cleveland County (Columbian-Tankersley & Tim) North Carolina

This will acknowledge receipt of an original and two copies of the Audit Report, and an original and three copies of the Audit Certificate covering the site audit of the subject contract.

The report of the Foreign Assets with our approval and the Reports and Certificates have been distributed according to Section 3 of Supplement 1 of NMEA Circular 17.

We also wish to acknowledge receipt of our copies of the Operator's Monthly Report and Voucher for the months of May and July 1956.

Robert E. Lagrone

August 3, 1954

Mr. T. L. Kesler
Foote Minerals Co.
Box 31
Kings Mountain, North Carolina

Re: DMEA-2841, Idm-E523
(Columbium-Tantalum-Tin)

Dear Tom:

Transmitted herewith are copies of the Audit Certificate and the Audit Report covering the site audit of the above cited contract. Your May and July vouchers are being sent to the Finance Office today and payment will be made according to the findings of the auditor. This will amount to 90 percent of the difference of the total accepted costs $23,735.10 and the "Total to Date" on your April voucher which was $22,391.63 or 90 percent of $1,343.47 which amounts to $1,209.12.

We wish to thank you for the cooperation of you and your associates on this contract. It has been a pleasure working with you.

Very truly yours,

Robert A. Laurence, Executive Officer
DMEA Field Team, Region VII

WAB/zm
cc:
Beck
Opr. Com.
Files

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Y

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

JUL 29 1954

Mr. Robert A. Lawrence
Executive Officer
DMEA Field Team, Region VII
Room 13, Post Office Building
Knoxville 2, Tennessee

Re: DMEA-2841, Idm-F523
Foote Mineral Company
Cleveland County, N. C.

Dear Mr. Lawrence:

Enclosed are an original and two copies of the Audit Report and an original and three copies of the Audit Certificate covering the site audit of the above-cited contract.

Distribution of these reports and certificates should be made in accordance with the provisions of Sec. 3 to Supl. 4 of DMEA Circular 19.

There are also enclosed your copies of the Operator's Monthly Report and Voucher for the months of May and July, 1954.

Sincerely yours,

(Signed) J. L. Chambers

Jay L. Chambers, Chief
Contract Administration
and Audit Division

Enclosure

WBorovies/wb
July 29, 1954

Copy to: Docket
Admr. Reading File
Mrs. Cora Piper
Mr. Chambers

R.C.S.

Department of the Interior

Defense Minerals Exploration Admin.

14X4401(01) Revolving Fund, Defense Production Act, Interior (Allocated Working Fund to the Office of the Secretary)

Talbert

JUN 2 1954

MR. ROBERT A. LAURENCE
EXECUTIVE OFFICER
DMEA FIELD TEAM, REGION VII
ROOM 13, P. O. BUILDING
KNOXVILLE 2, TENNESSEE

RE DMEA-2841, IDM-E523, FOOTE MINERAL COMPANY. PLEASE ADVISE IF ACCOUNTING RECORDS ARE AT KINGS MOUNTAIN, NORTH CAROLINA, AND WHETHER FINAL AUDIT MAY BE MADE ON JUNE 7, 1954. PRESENCE OF REPRESENTATIVE FROM YOUR OFFICE NOT DEEMED NECESSARY; HOWEVER AUDITOR WILL RETURN VIA KNOXVILLE FOR CONSULTATION.

(Signed) E. D. Talbert

E. D. TALBERT, ACTING CHIEF
CONTRACT ADMINISTRATION
AND AUDIT DIVISION

EDTalbert/wb
June 2, 1954

Copy to: Docket
Admr. Reading File
Mr. Chambers

R.C.S.

May 19, 1954

Mr. T. L. Taylor, Chief Geologist
Foote Mineral Company
P.O. Box 11
Kings Mountain, N. C.

Re: [illegible]
Gallupite-Tantalite-Beryl-Tin

Dear John:

Your April monthly report and vouchers is being returned to you herewith because they were not signed by your plant accountant. Dr. Fuhr has retained the copy that I do not feel that it will be necessary for return the copy. You may return these vouchers direct to this office. It will not be necessary to transmit this through Dr. Fuhr as he has already signed them.

Please advise us whether or not there are any more expenses to be vouchered and if so, approximately how much. If there are no more vouchers it will be necessary for us to hold these until the final report is received.

Very truly yours,

W. J. Fuhr, for R. A. Lawrence
Executive Officer, USGS-Reg. VII

Lawrence
Cox
Roth
Fuhr
Cpt. Sup. - 2
Files

April 26, 1954

Memorandum

To: Hazel Berry, Operating Committee

From: Grace L. Ault, Rare & Misc. Metals Division

Subject: Amendment to contract

Mr. Ching has reviewed and approved Amendment No. 6, dated April 13, 1954, to Contract No. Idm-2523, Docket No. DMEA-2841, Foote Mineral Company.

/s/ Grace L. Ault

Grace L. Ault

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.
ROOM 13, POST OFFICE BLDG.
KNOXVILLE 2, TENN.

April 20, 1954

Memorandum

To: Operating Committee, D M E A - Washington

From: Executive Officer, DMEA - Region VII

Subject: Amendment No. 6 on DMEA-2841, Idm-E 523. Foote Mineral Co.

Transmitted herewith are three signed copies of the subject amendment. The usual distribution of the other copies has been made.

This amendment was necessary to provide time for completion of the analyses without disruption of the laboratorys schedule.

Robert A. Laurence

Robert A. Laurence

RECEIVED
MAY 6 - 1954
GENERAL COUNSEL
DEFENSE MINERALS
ADMINISTRATION

March 15, 1954

Memorandum

To: Hazel Berry, Operating Committee

From: Grace L. Ault, Rare & Misc. Metals Division

Subject: Amendment to contract

Mr. Ching has reviewed and approved Amendment No. 5, dated March 3, 1954, to Contract No. Idm-8523, Docket No. DMSA-2641, Foote Mineral Company.

/s/ Grace L. Ault

Grace L. Ault

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
ROOM 1, POST OFFICE BLDG.
KNOXVILLE 2, TENN.

Department of the Interior
Defense Minerals Exploration Administration
RECEIVED
MAR 12 1954

March 10, 1954

Memorandum

To: Operating Committee, D M E A - Washington

From: Executive Officer, D M E A- Region VII

Subject: Foote Mineral Company - Amendment No. 5. DMEA-2841, Idm-E 523.

Enclosed are the original and 2 copies of Amendment No. 5 to the subject exploration contract. Justification of this extension of time is contained in the letters from T. L. Kesler, Chief Geologist, Foote Mineral Co., and B. F. Buie, Geologist, U. S. Geological Survey, four copies of which are enclosed herewith.

Robert A. Laurence

Robert A. Laurence

RECEIVED
MAR 18 1954
GENERAL COUNSEL
DEFENSE MINERALS
ADMINISTRATION

C O P Y

C O P Y

Union Mines
MAR 12 1954

R. F. D. 5

Columbia, S. C.

March 2, 1954

Mr. R. A. Laurence, Executive Officer
DMEA Field Team, Region 7
Room 13, Post Office Building
Knoxville, Tennessee

DMEA-2841, Idm-E 523

Dear Mr. Laurence:

Enclosed are four copies of a letter dated February 19, 1954 from Thomas L. Kesler, Chief Geologist, Foote Mineral Company, requesting an extension of one month in the period of the contract for DMEA docket 2841, Contract Idm- E 523.

I recommend that Mr. Kesler's request be granted, the expiration date then to become April 18, 1954. It has been my observation that the Company has carried out its work under this contract diligently and energetically. Core drilling has been continued on Saturdays, Sundays and holidays during the latter part of the period. There have been some unavoidable delays, beyond the control of the Company. The work is now progressing well, and there should be no difficulty in completing the field work by April 18, 1954.

Sincerely,

s/ B. F. Buie
Geologist.

copied by zm.
SIC.

February 19, 1954

Dr. B. F. Buie,
Geologist, D.M.E.A.
Field Team, Region VII
R. F. D. #5
Columbia, South Carolina

Dear Frank:

Through your visits to inspect our work on contract No. IDM - E 523, Docket No. 2841, you are aware that we are running very close to our present deadline in completing the core drilling and trenching.

The purpose of this letter is to request a months extention of the contract as a safety feature in case bad weather and break-downs should delay completion of the work. If this extention is granted, it is my understanding that the expiration date would then be April 18. It is also my understanding that our final report on this work to D.M.E.A. will not be required within the deadline date, this being due largely to the necessity of assaying samples that may be taken up to that date.

Yours very truly,

FOOTE MINERAL CO:

Thomas L. Kesler,
Chief Geologist

TLK/br

CC: F. B. Shay
L. G. Bliss

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
ROOM 3511 POST OFFICE BLDG.
KNOXVILLE 2, TENN.

Defense Mineral Administration
RECEIVED
MAR 12 1954

March 10, 1954

Memorandum

To: Operating Committee, DMEA - Washington

From: Executive Officer, DMEA - Region VII

Subject: Amendment No. 4. DMEA-2841, Idm-E 523. Foote Mineral Co.

Transmitted herewith are three copies of amendment No. 4 signed by Mr. L. G. Bliss, president of the Foote Mineral Company. The usual distribution of the other copies has been made.

Robert A. Laurence

Robert A. Laurence

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

RECEIVED
FEB 1954

INTERIM REPORT NO. 8

DMEA Docket No. 2841, Idm-E 523
(Columbium-Tantalum, Beryl and Tin)

FOOTE MINERAL COMPANY

The exploration project being conducted by Foote Mineral Co. of 18 W. Chelten Ave,, Philadelphia, Pa., on leases located approximately four miles southwest of Kings Mountain, N. C., was examined on February 18, 1954 by the undersigned, representing the Geological Survey, in the presence of Mr. Ed Dill, representing the Foote Mineral Company.

The conduct of the exploration work appears to be in accordance with the terms of the contract. Core recovery continues to be excellent, as has been the case except in the very early stages of this project.

Examination was made on core from that part of Hole 3-1-1 below 84.5 ft., drilled since the preceeding visit on January 29; on core from Hole 3-2-2; and on core from approximately 90 ft. of Hole 3-3-1. Also seven trenches, blasted and prepared for sampling, were examined.

Hole 3-1-1, inclined 45 degrees S 50 E, yielded 0.3 ft. of what may be fine grained pegmatite at approximately 109 ft., and 1.6 ft. of fine grained pegmatite between 122.0 and 123.6. Core recovery was 100 percent. Neither spodumene nor any of the minerals mentioned in the contract was observed by megascopic examination. The bottom of the core is at 131.0 ft., though Mr. Dill stated that the core barrel was lost in this hole with 6.4 ft. of core, and that total depth was 137.4 ft.

In Hole 3-2-2, inclined 60 degrees S 50 E, coring was begun at 20.3 ft., in pegmatite. Intervals of pegmatite were:
20.3 - 22.0 Weathered fine grained pegmatite; a little spodumene.
29,3 - 52.3 Moderately fine grained pegmatite; some spodumene.
Bottom of core is at 120.6. Mr. Dill stated that circulation was lost at 25.3 ft. and was not reestablished; accordingly, no sludge samples were obtained from the pegmatite between 29.3 and 52.3. The core shows the rock to be jointed and badly weathered; so much so that the loss of circulation is to be expected.

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

Interim Report No. 8, DMEA docket No. 2841, Idm-E 523 cont'd.

Hole 3-3-1, inclined approximately 50 degrees S 45 E, was non-coring from the surface to 34.9 ft. Core was as follows:

34.9 - 73.7	Coarse grained micaceous pegmatite; no Columbite-tantalite, beryl or tin were recognized; contains very little, if any, spodumene.
73.7 - 86.0	Finely laminated mica schist.
86.0 - 86.8	Coarse grained pegmatite with much spodumene.
86.8 --	Reenter mica schist

Mr. Dill states that circulation of water was lacking between 64.5 and 73.8, hence no sludge samples were obtained for that interval.

Three trenches in pegmatite 3-1, three in pegmatite 3-5, and one in pegmatite 3-2 have been opened by drilling and blasting. From the material blasted loose, samples approximating 6 by 6 inch channel samples are to be collected. The total trenching done is about 425 feet. The Company does not propose to do additional trenching.

After the completion of the field examination, E. L. Kesler, Chief Geologist for Foote Mineral Co., stated that the non-coring footage drilled is being counted as a part of the 2100 feet of drilling authorized. I recommend that the Operator be compensated for non-coring drilling in accordance with the proposal set forth in a memorandum dated Dec. 15, 1953 from Robert A. Laurence and Wm. A. Beck to the Operating Committee. The proposed rate of compensation, $2.35 per foot for non-coring drilling, appears to be fair and reasonable.

B. F. Buie

B. F. Buie, Geologist (W.A.E.)
U. S. Geological Survey

Columbia, S. C.
March 3, 1954

Note: In Interim Report No. 7 the first sentence of the third paragraph should read: "From Hole 3-6-1, below 55.3 feet to total depth of 125.6 feet, core recovery was 100 percent."

FOOTE MINERAL COMPANY

EXPLORATION DEPARTMENT—LOG FORM

DIVISION: Kings Mtn PROPERTY OR MINE: Tract #3 DRILL HOLE NO.: 3-1-1 CHANNEL OR TRENCH NO.: LOCATION:

SURF. ELEV.: INCLINATION: 45° BEARING: S-50-E SIZE OR WIDTH: W to 16.3; NX STARTED: 1-20-54 COMPLETED: 1-31-54

FROM	TO	PEN.	CORE	% REC.	MATERIAL AND REMARKS	SAMPLE
1.0	16.3	16.3	—	W	Red Clay & Weathered Mica Schist	
16.3	74.5	58.2	37.2	62	Weathered Mica Schist & Amphibolite	
74.5	122.0	47.5	47.0	99	Fresh " " " "	
122.0	123.6	1.6	1.6	100	Fresh Peg.	3-1-1-C1
123.6	137.4	13.8	7.4	54	" Mica Schist & Amphibolite	
					From 77.0 to 79.0 - Unusually Contorted -	
					Foliation of Mica Schist.	

COPY

FOOTE MINERAL COMPANY

EXPLORATION DEPARTMENT—LOG FORM

DIVISION [illegible] PROPERTY OR MINE [illegible] DRILL HOLE NO. [illegible] CHANNEL OR TRENCH NO. [illegible] LOCATION

SURF. ELEV. INCLINATION 45° BEARING [illegible] SIZE OR WIDTH [illegible] STARTED [illegible] COMPLETED [illegible]

FROM	TO	PEN.	CORE	% REC.	MATERIAL AND REMARKS	SAMPLE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	WEATHERED MICA SCHIST [illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	" " "	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	EARLY FOLIED AMPHIBOLITE	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	FRESH PEGMATITE	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	" MICA SCHIST	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	" PEGMATITE	3-2-1-61
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	" MICA SCHIST	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	" PEGMATITE	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	" MICA SCHIST	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	" PEGMATITE	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	" AMPHIBOLITE	
[illegible]	[illegible]			[illegible]		3-2-1-62
[illegible]	[illegible]			[illegible]		3-2-1-63
[illegible]	[illegible]			[illegible]		3-2-1-64
[illegible]	[illegible]			[illegible]		3-2-1-65
[illegible]	[illegible]			[illegible]	FRESH PEGMATITE	3-2-1-66
[illegible]	[illegible]			[illegible]		3-2-1-67
[illegible]	[illegible]			[illegible]		3-2-1-68
[illegible]	[illegible]			[illegible]		3-2-1-69
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	FRESH MICA SCHIST WITH SEVERAL THIN LENSES OF PEGMATITE	
					SAMPLES [illegible] 3-2-1-62	
					3-2-1-59 [illegible] 3-2-1-61 ; 3-2-1-62 [illegible] 3-2-1-63	
					3-2-1-63 ; 3-2-1-65 ; 3-2-1-66 ; 3-2-1-67 ; 3-2-1-68	
					3-2-1-69	

COPY

Surname
Doc[redacted] Copy

700

Ching
Ellis
Chandler
Selfridge
[illegible]

MAR 1 1954

Mr. Robert A. Lawrence
Executive Officer
DMEA Field Team, Region VII
Room 11, Post Office Building
Knoxville 2, Tennessee

Re: Docket No. DMA-2841
(Columbite-tantalite-beryl and tin)
Contract No. Ma-2523
Foster Mineral Company
Williams Tracts 3 and 4
Cleveland County, North Carolina

Dear Mr. Lawrence:

In accordance with your memoranda of December 15, 1953, and February 15, 1954, we have drawn up and are enclosing the original and five copies of proposed Amendment No. 4 to the captioned contract, signed by the Administrator.

Please have the documents properly signed, retain copies for the Operator, Field Team, and Finance Officer, and return the remaining copies to this office.

Sincerely yours,

George C. Selfridge (GCS)

Chairman, Operating Committee

APPROVED:

J. H. Hedges

Director, Bureau of Mines (JHH)

D. M. Larrabee

Director, Geological Survey (DML)

MChing 2-26-54
cc to: Adm. Reading File
Operating Committee
Docket
Messrs. R. F. Griffith, Rm. 3641A
D. M. Larrabee, Rm. G-232, GSA
M. Ching
Code 700

R.C.J. 3-1-54

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
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FEB 17 1954

INTERIM REPORT No. 7

DMEA-Docket No. 2841, Idm-E 523

(Columbium-Tantalum, Beryl and Tin)

FOOTE MINERAL COMPANY

This interim report covers visits on January 22 and 29, 1954 to the exploration project being conducted by Foote Mineral Co., of 18 W. Chelton Ave., Philadelphia, Penna., on leases located approximately four miles southwest of Kings Mountain, N. C. Examination was made by the undersigned on behalf of the Geological Survey. The Foote Minerals Company was represented by T. L. Kesler, Chief Geologist and Ed Dill, Geologist.

Exploration work done since the previous visit on December 30, 1953 was reviewed; the core from Hole 3-2-1 , Hole 3-1-1, and that part of Hole 3-6-1 below 55.3 feet was examined; and plans for the location of future drill holes and trenches were outlined and approved.

From Hole 3-6-1, below 55.3 feet to total depth of 125.6 feet, was 100 percent. It was agreed that assays would be run on the cores of all pegmatite encountered, being intervals as follows:

57.0	- 59.0	feet
66.1	- 68.9	"
72.8	- 74.2	"
91.6	- 92.8	"
108.3	- 109.1	"

This pegmatite is the spodumene-bearing type, being different than the pegmatite exposed at the surface and penetrated in the upper part of this hole (see Interim Report # 6). Mr. Dill, who was present when this core was examined, stated that the sludge samples had been too contaminated to save.

Hole 3-2-1 is inclined at 45 degrees, S 50° E. Coring was begun at 27.7 feet. The core revealed pegmatite as follows:

42.5 - 43.0	weathered pegmatite
55.0 - 55.8	pegmatite with spodumene
56.5 - 57.0	pegmatite with stringers of schist.
75.8 - 83.6	pegmatite with some spodumene; minute dark specks, possibly columbite.
93.7 - 94.4	Fine grained schistose pegmatite or quartzite
104.8 - 105.6	Pegmatite with a little spodumene
115.3 - 154.5	Pegmatite with several schist zones to 0.2 feet in thickness; some spodumene

T.D. 225.0

It was agreed that assays would be obtained for one core and one sludge sample for the interval 75.8 - 83.6, and for a core sample for

each five foot interval from 115.3 to 154.5; also that an assay would be obtained for each sludge sample taken between 115.3 and 154.5, these being composite for each five-feet interval.

Because of shortage of time, inclement weather, and illness of Mr. Kesler, it was impractical on January 22 to examine and agree upon the sites where trenches are to be placed. Mr. Kesler requested that an early return trip be made for that purpose.

On January 29 the proposed sites for trenches, as marked on the ground by Mr. Dill, were examined. The proposed sites were agreed upon after minor changes were introduced. The total footage of the trenches agreed upon cannot be determined accurately in advance, but it is estimated that the nine trenches will not be more than 680 feet.

It appears that some difficulty may be encountered in finding suitable and appropriate places for the 2140 feet of tenching authorized in the contract.

On January 29, Hole 3-1-1, inclined approximately 45 degrees, S. 50° E, had been drilled to 84.5 feet. All of the core is country rock except for a few stringers of pegmatite not more than 0.2 feet in thickness. Core from immediately below 64.1 feet shows crumpling and an abrupt change in orientation of the schistosity, apparently the result of faulting. Faulting may account for pegmatite not having been encountered in this hole where it was expected on the basis of surface outcrop and the core from Hole 3-2-1.

The Company appears to be conducting the exploration diligently and in accordance with the terms of the contract. Difficulty in obtaining repair parts for some of the drilling equipment has caused some unavoidable delay.

B. F. Buie, Geologist , W. A. E.
U. S. Geological Survey

zm

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
ROOM 13, POST OFFICE BLDG.
WASHINGTON 25, D. C.
KNOXVILLE 2, TENN.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
FEB 17 1954

February 15, 1954

Memorandum

To: Operating Committee, DMEA - Washington

From: Executive Officer, DMEA - Region VII

Subject: Docket No. DMEA-2841, Idn-E 523 (columbium-tantalum)
Foote Minerals Company, Cleveland County, N. C.

Please refer to our memorandum of December 15, 1953, requesting that an amendment be made to the subject contract to reimburse the contractor for non-coring footage and advise us what action, if any, has been taken on our request. The Operator has been inquiring as to the status of this amendment.

Robert A. Laurence

Robert A. Laurence

FILE COPY
SURNAME:

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION 140
WASHINGTON 25, D. C.

JAN 18 1954

Mr. Robert A. Laurence, Executive Officer
DMEA Field Team, Region VII
Room 13, Post Office Building
Knoxville 2, Tennessee

Re: Docket No. DMEA-2841
Foote Mineral Company
(Columbium-Tantalum-Beryl & Tin)
Cleveland County, North Carolina
Contract No. Idm-E523

Dear Mr. Laurence:

Reference is made to your letter of December 29, 1953, to Mr. B. F. Buie in answer to three questions raised in his Interim Report No. 5.

We note that your first answer states that the final report must be completed within the time fixed for completion of the project. This view is not in accord with the intent of the contract provisions concerning the final report and, at any rate, is not in accord with our practice. We have considered the date fixed in the contract for completing the project as the date for completing the actual exploration work, and have allowed a reasonable time thereafter for preparation of an adequate final report. In our experience, most operators require this additional time, and an amendment of the contract in order to allow the time would be administratively burdensome.

Therefore, please convey the foregoing viewpoint to Mr. Buie so that a uniform practice will be followed in connection with this question.

Sincerely yours,

George C. Selfridge (JB)
Chairman, Operating Committee

Approved:

J. H. Hedges (JB)
Member, Bureau of Mines

T. P. Thayer (JB)
Member, Geological Survey

HCRubin/ema 1-13-54
cc: Docket
Adm. R. File
Op. Comm.
Mr. Thayer
Mr. Hedges
E. W. Ellis
J. L. Hofflund
H. C. Rubin
Chron. Pending

R.C.G. 1-18-54

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JAN 21 1954

INTERIM REPORT 6

DMEA Docket No. 2841, IDM-E 523
(Columbium-Tantalum, Beryl & Tin)
FOOTE MINERAL COMPANY

The exploration project being conducted by Foote Mineral Co., of 18 W. Chelten Ave., Philadelphia, Pa., on leases located approximately four miles southwest of Kings Mountain, N. C.was examined on Dec. 30, 1953 by the undersigned, representing the Geological Survey, in the presence of T. L. Kesler, Chief Geologist of Foote Mineral Company.

The conduct of the exploration work appears to be in accordance with the terms of the contract. It may be necessary for the Company to obtain a slight extension of the contract period to allow for obtaining assays of the final samples and for writing the final report.

A copy of Mr. Laurence's letter of December 29, addressed to the undersigned in reply to questions raised in Interim Report No. 5, was given to Mr. Kesler for the information and guidance of the Company. It was agreed with Mr. Kesler that assays will be run on splits of all sludge samples taken so far. There have been, and probably will continue to be, very few instances where the assaying of sludge samples can be omitted onthebasis of good recovery of NX core.

Splits of the core and sludge samples are made by the Company, at Kings Mountain, and are sent to the Company's laboratory in Pennsylvania for assaying.

Since the previous visit (Interim Report 5) Hole 3-5-1 has been deepened to 126.0 feet. Between 87.7 and 94.9 feet this hole yielded core of fresh pegmatite containing an estimated 30 percent of spodumene. No columbite-tantalite, cassiterite, or beryl wasrecognized, except as noted in Interim Report 5 for this hole. (Note: Study of the core for this hole revealed an error of 1 foot in the log. The figure "88.7" in Interim Report 5 should be "87.7".)

Hole 3-5-2 (Inclined hole) between 16.0 and 53.3 revealed pegmatite containing a few black specks which may be columbite, and a variable amount of spodumene which in some parts of the core appeared to constitute 50 percent of the pegmatite.

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

Hole 3-6-1, located about 200 feet N 10° W from Hole 3-5-1, is in a body of micaceous pegmatite. The conspicuous books of muscovite, to 3 inches or more in diameter, distinguish this pegmatite from the others drilled. Results at time of this inspection were as follows:

0.0 - 2.9 ft. Not cored. Logged as weathered pegmatite.
2.9 - 13.5 Weathered pegmatite.
13.5 - 49.3 Logged as weathered pegmatite, amphibolite and mica schist. Only about 4.5 ft. of core recovered, including 0.8 ft. of coarse grained pegmatite containing abundant muscovite.
49.3 - 53.2 Fresh mica schist.
No spodumene or columbite-tantalite, beryl or cassiterite were recognized in the core from depth of less than 53.2, at which depth the drill entered a different type of pegmatite from that encountered in the upper part of this hole.

53.2 - 55.3 Fresh pegmatite, containing much spodumene but no recognizable columbite-tantalite, beryl or cassiterite.

55.3 - Drilling in mica schist.

It was agreed with Mr. Kesler that pegmatite 3-5, which has been drilled by one vertical and one inclined hole, will be further explored by trenching about 75 feet along the direction of the inclined hole, across the strike. It was also agreed that trenching will give sufficient additional exploratory information on this pegmatite body, and that additional drilling in it will not be required.

B. F. Buie

B. F. Buie,
Geologist (W.A.E.)

Columbia, S. C.
January 17, 1954

c: Beck
Lynch
Larabee
Kesler
Files

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
~~WASHINGTON 25, D.~~ C.
ROOM 13, POST OFFICE BLDG.
KNOXVILLE 2, TENN.

Defense Minerals Administration
RECEIVED
DEC 31 1953

December 29, 1953

Mr. B. F. Buie, Geologist
R. F. D. #5
Columbia, South Carolina

Re: DMEA-2841, Idm-E 523.
Foote Mineral Co. (Columbium-Tantalum, Beryl-Tin)

Dear Mr. Buie:

In answer to the 3 questions asked in your interim report No. 5:

1. It is necessary to complete the final report within the contract period. Further, it is a simple matter to extend the contract by amendment, which we will be glad to do when the time comes, if it is needed.

2. If good core recovery is made, especially when it is NX size, assays of sludge samples would be superfluous. On the other hand, a BX core provides a much smaller sample, and if good sludge recovery is made both core and sludge should be saved and assayed separately, to provide a larger sample of that particular run. If poor recovery is made, regardless of size, then the sludge should be saved and assayed, with the notation that sludge recovery is good or bad, as the case may be and therefore the reliability of the sample may be judged accordingly.

All sludge samples should be saved for possible future use, but if the Company is unable to store them, you should keep them until Mr. Beck can pick them up and take them to Asheville for storage.

3. Only those parts of the dikes that are to be sampled by channeling need to be cleared and exposed. It is not necessary that the maximum footage of channeling be done if conditions indicate that this would be undesirable, as Kesler recently suggested in a phone conversation. Agreement between you and Kesler on the desirability of sampling would be sufficient basis for deciding how much clearing and channeling is to be done.

The Christmas mail rush and long holiday week-end delayed receipt of your report. A copy is being sent to you in care of Tom Kesler in the hope that it will reach you on December 30 at Kings Mountain.

Best wishes for the New Year.

Sincerely yours,

Robert A. Laurence, Executive Officer
DMEA Field Team, Region 7

RAL/sm

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

DEC 31 1953

INTERIM REPORT 5

DMEA Docket No. 2841, IDM-E 523
(Columbium-Tantalum, Beryl & Tin)
FOOTE MINERAL COMPANY

The exploration project being conducted by Foote Mineral Co., of 18 W. Chelten Ave., Philadelphia, Pa., on leases located approximately four miles southwest of Kings Mountain, N. C. was examined on Dec. 11, 1953 by the undersigned, representing the Geological Survey, in the presence of T. L. Kesler, Chief Geologist of Foote Mineral Co.

All exploration work since the preceeding visit, Nov. 20, has been in Tract No. 3. The drillers are still having some difficulty collecting sludge samples, but this appears to be unavoidable, and not in violation of the terms of the contract. It is noted that the contract states that sludge will be sampled in accordance with standard practice. The work appears to be in conformity with the terms of the contract. Core recovery in recent holes has been near 100 per cent.

The ninth hole (Hole 3-5-1) was drilled vertically to a depth of 92.8 feet. Mr. Kesler stated that this hole will be deepened when additional BX bits arrive. Summary log for this hole:

0 - 31.5 ft.	Mica schist, amphibolite & quartzite. Not-cored.
31.5 - 69.8	Fresh pegmatite with much spodumene and some minute plates of columbite. Core recovery 100 %
69.8 - 88.7	Amphibolite and mica schist. Core recovery 90 %
88.7 - 92.8	Fresh pegmatite with much spodumene and possibly a little columbite. Core recovery 100 %

It was agreed that eight assays would be made of the pegmatite core between 31.5 and 69.8 ft., in Hole 3-5-1, which will be approximately one assay for each five feet of core. Selection of assay samples below 69.8 ft. will await further drilling into the lower pegmatite zone.

The tenth hole (Hole 3-5-2), inclined 45 degrees, was started Dec. 11. Casing was seated and coring begun at 16 ft. At time of this visit pegmatite was being cored at 20 feet.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

IN REPLY REFER TO:
DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
DEC 31 1953

Interim Report 5, DMEA 2841, IDM-E 523,Foote Mineral Co., Cont'd.

The following questions were raised by Mr. Kesler:

1. Must all assays and the writing of the final report be completed within the contract period?

2. What is to be done with the sludge samples?

Regarding question 1, it is my interpretation that the contract period refers only to the actual field exploration, and that a reasonable length of time will be allowed after the end of the contract period for obtaining assays of the last cores and for preparation of the final report. However, I should like to have this interpretation confirmed before I state it to the company.

Regarding question 2, I request instructions. In general on this project sludge recovery has been poorer than core recovery. The holes, or portions of holes, which yielded a low percentage of core were ones in which return circulation and sludge recovery were deficient or lacking. Now that the driller is getting better return circulation and sludge recovery, he is also getting near 100 percent core recovery. Accordingly, it appears to me that the sludge samples will be of value for only limited portions of the drilling. Unless instructed otherwise, I do not plan to request that assays be made of any of the sludge samples from portions of the drilling which yielded as much as 90 percent of recovered core. The sludge samples are now being held by the Company.

In addition to the questions raised by Mr. Kesler, I should like advice regarding the fifth paragraph of EXHIBIT "A" of the contract, which I quote here in full:

> "The outcrops of the dikes will be exposed and cleared by bulldozer and hand work."

It is my interpretation that the paragraph quoted should refer only to such parts of the dikes as are to be sampled by channeling. But a literal interpretation could mean that all outcrops of all pegmatite dikes in the two tracts must be exposed and cleared.

B. F. Buie

B. F. Buie
Geologist (WAE)

Columbia, S.C.
December 20, 1953

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.
ROOM 13, POST OFFICE BLDG.
KNOXVILLE 2, TENN.

Defense Minerals Administration
RECEIVED
DEC 17 1953

December 15, 1953

Memorandum

To: Operating Committee - D M E A - Washington

From: Field Team, D M E A - Region 7

Subject: Docket No. DMEA-2841 (columbium-tantalum) Contract Idm-E 523, Foote Mineral Company, Cleveland County, N. C.

Reference is made to your letter of November 3, 1953, in regard to an amendment to the subject contract to reimburse the Operator for roller bit drilling.

On November 6 we wrote Mr. Kesler, their Geologist, for information as to the extent of this type of drilling and to give us some idea as to its cost. On November 12 he wrote us that his tentative decision was to claim no reimbursement if it was to be included in the total footage set up in the contract. Under date of December 9, Mr. Kesler wrote (copy of letter attached) giving costs of roller bit drilling to date and stating that he would like to reconsider his tentative decision and requested that they be reimbursed for non-coring footage from the beginning of the contract at a cost of $2.35 per foot.

The Field Team feels that the Operator should receive credit for roller bit footage drilled and the cost of $2.35 per foot is a reasonable figure. It is therefore requested that an amendment to the contract be made to include this item.

Robert A. Laurence
Robert A. Laurence
EXECUTIVE OFFICER
DMEA REGION VII

Wm. A. Beck
Wm. A. Beck, Acting for
V. J. Lynch
U. S. Bureau of Mines

C O P Y C O P Y

FOOTE MINERAL COMPANY
December 9, 1952

DEC 17 1953

Mr. Wm. A. Beck, Acting
Executive Officer, DMEA
Region 7
Post Office Building
Knoxville, Tennessee

Re: Docket No. DMEA-2841
Contract Idm-E 523 - Foote
Mineral Company

Dear Bill:

In your letter of November 6, you asked for information as to the cost of our roller bit drilling in order to further amend our contract in order to reimburse our company for such drilling. You stated that this drilling would not increase the 2100 feet set up in the contract but would be included in that amount.

I replied under date of November 12 that it was my tentative decision not to claim such reimbursement. I have given this matter considerable thought since that correspondence and have accumulated some cost figures that are far more accurate than I had at that time. As a result, I would like to request that our contract be amended so as to include reimbursement for non-coring footage and for your use in this connection, I submit the following information.

Our total non-coring footage from the beginning of drilling in August to the end of November was 238.4 feet. Our total cost for labor and supplies for this footage was $517.79 and an allowance for depreciation (basis 10 years) on equipment used for this type of drilling was $42.40. Thus our total cost for this non-coring footage was $560.19, and the cost per foot was $2.35. I would like to reconsider my tentative decision and request that we be allowed this amount for our non-coring footage from the beginning of the contract.

If this amendment is granted, we can bill for the accumulated non-coring footage to the end of the month in which the amendment is added. We understand that this footage would then be a part of the total 2100 feet set up in the contract.

Very truly yours,

s/ T. L. Kesler
Chief Geologist

Copied by zm.
cc:
Opr. Com.
Beck
Laurence
Buie

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

INTERIM REPORT 3 SB4

DMEA Docket No. 2841, IDM-E 523
(Columbium-Tantalum, Beryl & Tin)
FOOTE MINERAL COMPANY

The exploration project being conducted by Foote Mineral Co., of 18 W. Chelten Ave., Philadelphia, Pa., on the Company's leases located approximately four miles southwest of Kings Mountain, N. C. was examined on November 20, 1953 by the undersigned, representing the Geological Survey. Mr. T. L. Kesler represented the Company.

The exploration work appears to be in conformity with the terms of the contract. Core recovery recently has been much better than in the first several holes drilled. All drilling since the preceeding visit, on October 23, has been in Tract 3.

The seventh hole (Hole 3-4-1), mentioned in Interim Report 3 and in the Company's Monthly Report for October, was drilled to a depth of 58.2 feet. It was agreed that two assays would be run on the core from the starting point for coring, at 16.2 ft., and the bottom of the zone of mixed pegmatite and schist at approximately 25 feet; and that one assay would be run on the pegmatite cored between 45.0 and 48.7 feet.

The eighth hole (Hole 3-4-2) was drilled to 138.9 ft. Recovery of core was exceptionally good, being 70 to 91 per cent to a depth of 37.6 ft.,and 100 per cent for that part of the hole below 37.6 ft. It was agreed that nine assays would be run on the seven pegmatite zones encountered. The drill penetration of the two thickest of these zones was 13.2 ft. and 6.0 ft.; all other zones were 2.6 ft. or less.

The ninth hole is being started on the east side of a small ravine, opposite Hole 3-4-2, to explore tha basal part of this pegmatite body.

B. F. Buie.

B. F. Buie, Geologist (WAE)
U. S. Geological Survey

November 26, 1953

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NOV 27 1953
U. ... Survey
Geologic Division
Knoxville, Tenn.

93

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.
ROOM 13 POST OFFICE BLDG.
KNOXVILLE 2, TENN.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
NOV 23 1953

November 19, 1953

Memorandum

cc 11-23

To: Operating Committee, DMEA, Washington

From: Executive Officer, DMEA, Region VII

Subject: DMEA-2841, Foote Mineral Company
Amendment No. 3

Transmitted herewith are the original and two copies of of the above-mentioned amendment being the Government's Copy, Docket Copy and Division Copy. One copy has been sent to the Finance Office, one retained in this office and one retained by the Foote Mineral Company.

Robert A. Laurence
Robert A. Laurence
Executive Officer

Enclosures 3

FILE COPY
SURNAME:

Ching
Ellis
Tulbert
Selfridge
Hopson

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION
WASHINGTON 25, D. C.

NOV 3 1953

Mr. Robert A. Laurence
Executive Officer,
DMA Field Team, Region VII
Room 13, Post Office Building
Knoxville 2, Tennessee

Re: Docket No. [illegible]-2[illegible]1
(Columbium-tantalum)
Contract No. [illegible]-523
Foote Mineral Company
Cleveland County, North Carolina

Dear Mr. Laurence:

Reference is made to the Field Team's memoranda of October 1[illegible] and 2[illegible], 1953, and your telephone conversations with members of the Share and Miscellaneous Metals Division, regarding proposed Amendment No. 3 to the captioned contract.

Enclosed please find original and five copies of said Amendment No. 3, signed by the Administrator. Kindly have the copies properly signed, retain the Operator's, Field Team's and Finance Officer's copies for distribution, and return the remaining copies to this office.

Very truly yours,

George C. Selfridge
Chairman, Operating Committee

Enclosures (

Concur:

J. H. Hedges
Member, Bureau of Mines

A. R. Kinkel, Jr.
Director, Geological Survey

HChing/gla
10-30-53

cc to: Adm. Reading File
Operating Committee
Docket
Messrs. H. E. Griffith, Rm. 3641A
D. M. Barrabee, Rm. 6-232, GSA
Ellis
Ching

R. C. 11-3-53

FILE COPY
SURNAME:

Ching
Ellis
Talbot
Selfridge
Hedges

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION
WASHINGTON 25, D. C.

NOV 3 1953

Mr. Robert A. Laurence
Executive Officer,
DMA Field Team, Region VII
Room 13, Post Office Building
Knoxville 2, Tennessee

Re: Docket No. A-2[illegible]1 (Columbium-tantalum)
Contract No. [illegible]-523
Coote Mineral Company
Cleveland County, North Carolina

Dear Mr. Laurence:

This is with reference to that portion of the Field Team's memorandum of October 2[illegible], 1953, to Mr. Ellis regarding reimbursement to the operator for footage drilled with a roller bit.

It is our understanding that the roller bit is used only for drilling through weathered material until rock hard enough to set casing is reached, at which point drilling with a diamond bit is started. Since drilling with a roller bit is usually considerably cheaper than with a diamond bit, we would not be justified in paying the same price unless there is reasonable assurance that such roller bit drilling is very limited in extent and entails enough added labor and time for preparation and changing over to the diamond bit as to nullify any monetary advantage derived from this type of drilling. On the other hand, it is only reasonable that the operator receive credit for footage drilled.

We suggest that you secure detailed information on the extent of the roller bit drilling and, if possible, further justify an equal rate of payment for roller bit footage.

The amendment to the subject contract proposed in prior portion of the Field Team's memorandum is being covered by separate action.

Sincerely yours,

George C. Selfridge

(GCS)

Chairman, Operating Committee

CONCUR:

J. H. Hedges (JHH)
Member, Bureau of Mines

A. R. Kinkel, Jr. (ARK)
Member, Geological Survey

MCHing/cla
10-30-53
cc to: Adm. Reading File
Operating Comm'ttee
Docket
Messrs. J. L. Griffith, Rm. 3614
J. H. Larrabee, Rm. 7-232, GAO
Ellis Ching

1C.S.
11-3-53

Defense Minerals Administration
RECEIVED
NOV 4 1953

INTERIM REPORT 3

DMEA Docket No. 2841, Idm-E 523
(Columbium-Tantalum, Beryl & Tin)
FOOTE MINERAL COMPANY

The exploration project being conducted by Foote Mineral Co., of 18 W. Chelten Ave., Philadelphia, Pa., on the Company's leases located approximately four miles southwest of Kings Mountain, N. C. was examined on October 23 by Wm. A. Beck, representing the Bureau of Mines, and B. F. Buie, representing the Geological Survey.

The exploration work appears to be in conformity with the terms of the contract, except that difficulty still exists in obtaining sludge samples. The driller states that this results from lack of return circulation in drilling through zones of weathered rock below the point at which casing is set on the first firm rock. Recovery of core from recent holes has been satisfactory, but because of lack of return circulation and consequent danger of the tools becoming stuck, drilling has been discontinued in some holes at shallower depth than is desirable.

The fifth hole (Hole 4-3-2) which was being drilled at the time of the preceeding visit, reached a depth of 60.1 feet at which depth the tools became stuck. Fairly fresh pegmatite was cored between 23.7 and 42.9 feet. It was agreed that four assays on this core would be adequate.

The sixth hole (Hole 4-1-3) entered pegmatite at 2.9 and was stopped in weathered pegmatite at 33.1 feet, where the hole became choked with cuttings. It was agreed that five assays would be made on this core.

Total coring on Tract 4, to October 23, was 250 feet.

The seventh hole (Hole 3-4-1) is the first hole on Tract 3. On October 23 drilling was being continued at 46 feet, after circulation had been lost at about 33.8 feet.

B. F. Buie, Geologist (WAE)
U. S. Geological Survey

Wm. A. Beck, Mining Engineer
U. S. Bureau of Mines

October 30, 1953

zm

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

October 30, 1953 DOCKET COPY

Memorandum

To: File

From: Michael Ching, Mining Engineer
Rare and Miscellaneous Metals Division

Subject: Proposed Amendment No. 3
Docket No. DMEA-2841 (Columbium-tantalum)
Contract No. Idm-E523
Foote Mineral Company
Cleveland County, North Carolina

In a letter dated October 13, 1953, to the Executive Officer, Region VII, the Operator reported serious difficulties in carrying out the diamond drilling program outlined in the subject contract and requested that the contract be amended to allow BX (1-5/8" diameter) coring in place of NX (2-1/8" diameter) coring where necessary to improve efficiency of performance and sludge recovery. While Operator did not believe that such substitution would result in a reduction in the unit cost of drilling, the Field Team has advised that a reduction in the cost per foot from $7.80 to $7.00 when drilling with BX tools would probably be acceptable to the Operator.

In conferences with the Field Team, the Operator has also requested that the contract be amended to allow a Geologist-Engineer helper for a period of 6 months instead of 4 months, at $400 per month, and to allow for the use of a pick-up truck for 18 weeks instead of 6 weeks, at $30.00 per week. The Field Team concurs with the Operator that these changes are in accordance with requirements of the operation and will not affect the total amount of the contract since the increases will be compensated for by a corresponding reduction in the $1904.00 allowed for contingencies.

By memoranda dated October 14 and 26 and in a telephone conversation on October 26, the Field Team has recommended that the contract be amended as suggested above.

The completion date of the contract is due to expire on November 18, 1953. It is deemed advisable to extend such completion date to March 18, 1954, since the greater portion of the drilling is yet to be done.

Michael Ching
Michael Ching

DRAFT
10/28/53
MChing/gla/

Keep for Division file

AMENDMENT NO. 3

Contract No. Idm-E523, Docket No. DMEA-2841, dated May 18, 1953, between the United States of America and Foote Mineral Company, is hereby amended as follows, effective as of the date of said contract:

Under Article 3, Exploration Project, delete the words "six (6) months" and substitute the words "ten (10) months".

In Exhibit "A", as amended:

Under "Description of the Work", delete the third paragraph and substitute the following:

The dikes in Tracts 3 and 4 will be explored by seven or more diamond drill holes having a total length not in excess of 2,100 feet, yielding cores having 2-1/8 inch diameter where practical and 1-5/8 inch diameter where a more efficient operation and better recovery of sludge samples are indicated.

Under "Estimated Costs of the Project", delete the whole and substitute the following:

Agreed Estimated Unit Costs

Diamond Drilling 2,100 feet @ $7.80/ft. (This unit cost is based on a 2-1/8" core. Where 1-5/8" core is substituted, the unit cost shall be $7.00 per foot.)	$16,380.00	
Channeling 2,140 feet @ $0.90/ft,	1,926.00	
		$18,306.00

(Next paragraph no change)

See executed Copy

Carried fwd.		$18,306.00

Estimated Actual Costs

(1) Independent Contracts

No change		500.00*

(2) Labor, Supervision, Consultants

1 Geologist-Engineer 4 mos. @ $500 per mo.*	$2,000.00*	
1 Geologist-Engineer helper 6 mos. @ $400 per mo.	2,400.00	
		4,400.00

(3) Operating materials and supplies

No change		350.00

(4) Operating equipment

To be furnished by Operator:

1 pickup truck for 10 hrs. per week 18 weeks @ $30.00 per week (Thisincludes all costs of operation, supplies, and maintenance)		540.00
(5) No change		
(6) No change		
(7) No change		160.00
(8) Contingencies		5,500.00* 744.00
Estimated Total Cost of the Project		$30,500.00*
Government Participation @ 90%		$27,450.00

This amendment shall not be construed to increase the estimated total cost of the project, the amount of the Government's contribution, or any item of allowable cost which is expressly designated "Allowable Maximum."

Dated: _____

FOOTE MINERAL COMPANY

By _____
Louis G. Bliss,
Vice President - Sales

UNITED STATES OF AMERICA

By _____
Administrator, Defense Minerals

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D.C.

EXECUTIVE OFFICER
DMEA, REGION VII
KNOXVILLE, TENNESSEE

October 26, 1953

Memorandum

To: E. W. Ellis, Chief, Rare and Miscellaneous Metals Div.

From: DMEA Field Team, Region VII

Subject: DMEA-2841, Idm-E 523 Foote Mineral Co. Proposed Amendment (Columbium-tantalum-beryl and tin)

This memorandum will confirm our telephone conversation of this date.

The weathered nature of the country rock and the pegmatite on this project has given considerable trouble both in delays in drilling, costs per foot drilled and results obtained. The Operator requested in previous correspondence that they be allowed to reduce the hole to BX size when necessary to get through the zone of weathered material. The Field Team is in agreement that NX hole be drilled as far as possible and then the Operator be allowed to case the hole and complete the hole BX size. We are also in agreement that the cost of BX drilling be set at $7.00 per foot instead of $7.80 per foot allowed in the contract for the NX drilling. It is felt that the Operator will agree to this reduction in order to get better results.

Under item 2 of exhibit "A" provision is made for a Geologist Engineer helper for four months @ $400 per month. Due to the delays encountered it is requested and the Field Team also recommends that the contract be amended to allow a Geologist-Engineer helper for a period of six months at $400 per month. No change in the amount set up for the Geologist-Engineer is requested and....

Under item 4 of exhibit "A" provision is made for a pick-up-truck - 2 hours per day, 5 days week for six weeks @ $3.00/hr----$180. It is requested and the Field Team recommends that this item be amended to allow for the use of a pick-up truck for 18 weeks @ $30.00 per week- $540.00

On this job the Operator is using a roller bit similar to the "Hughes Bit" for drilling through the weathered rock until they get to hard enough rock to set casing. They then drill with a diamond bit.

In the two vouchers we have received to date they have not requested reimbursement for any footage drilled other than that with a diamond bit. In most diamond drilling the contractor is paid per foot of hole from the surface to the bottom. We feel this should be true in this case and wish the opinion of the Operating Committee.

The above changes to the contract will not increase the total amount of the contract as any additional money can be taken from the $1904.00 allowed for contingencies and the savings gained by drilling BX instead of NX.

Robert A. Lawrence
Executive Officer, DMEA
Region VII

Wm A Beck
Wm. A. Beck, for V. J. Lynch
U. S. Bureau of Mines

10/21/53 gla

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
EXECUTIVE OFFICER
DMEA REGION VII
Knoxville, Tenn.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
OCT 16 1953

October 14, 1953

DOCKET COPY

Memorandum

To: Operating Committee, D M EA- Washington

From: D M E A Field Team, Region VII

Subject: DMEA-2841, Idm- E 523 (Columbium-Beryl,Tin) Proposed Amendment

Enclosed is a letter from the Operator's Chief Geologist, explaining difficulties encountered in obtaining NX cores in weathered ground, due to loss of water circulation. We discussed this on the phone with Mr. Kesler, and asked him to submit this written summary.

B. F. Buie, Geologist, U. S. Geological Survey, has visited the project recently and also discussed these conditions with Mr. Kesler. In his last interim report, copies of which were sent to Washington on October 13, Mr. Buie recommends that the Operator's request be approved.

We agree with Mr. Kesler that, under the conditions existing at Kings Mountain, taking NX cores is not always practical. Therefore, we recommend that the contract be amended to provide for reducing to BX whenever necessary. This will result in a more efficient operation and better recovery of sludge samples. We are not preparing the amendment here, as we prefer to have approval of the Commodity Group who prepared the contract. If they approve, will you please have an amendment prepared, or else authorize us to prepare the amendment here. No change in unit costs or total expenditures is requested.

Robert A. Lawrence
Executive Officer, DMEA
Region VII

Agree

W A Beck
Wm. A. Beck, for V. J. Lynch
U. S. Bureau of Mines

37

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

REPLY TO:
P. O. BOX 31
Kings Mountain, N. C.

RECEIVED
OCT 19 1953
Defense Minerals Administration

RECEIVED
OCT 14 1953
U. S. Geological Survey
Geologic Division
Knoxville, Tenn.

October 13, 1953

The Executive Officer, D.M.E.A.
Field Team, Region VII
Room 13, Post Office Bldg.
Knoxville, Tennessee

Dear Sir:

Some two weeks ago, I telephoned your office to report serious difficulties in our attempt to carry out diamond drilling under IDM-E 523, Docket No. DMEA 2841. I agreed to forward a letter of particulars, which has been delayed to this date by the temporary loss of a shipment of diamond bits, on which to base a dependable estimate of resetting cost. I received a report on this shipment, from our diamond bit supplier, only yesterday.

Our difficulties arise from alternating intervals of hard and soft rock within the zone of weathering. The soft material commonly takes part or all of the water circulation, making it impossible to obtain representative sludge samples, if any at all, until the zone of weathering has been passed. At this time the zone of weathering normally would be cased off if we were operating under standard practice, but, as we cannot use tools smaller than NX, our only casing has already been set on a higher interval of hard rock that is commonly near the surface. Consequently, our only course is to continue with little or no water return until the hole becomes choked with cuttings. This prevents sludge sampling, and has cost us one NX core barrel, one NX diamond bit, one NX diamond reamer shell, two N rods, and one connection having a total value of $410.50 with allowance for wear on the bit.

It is necessary to add at least one more set of tools in order to permit sub-casing below the zone of weathering. We request that the contract be amended to allow BX coring, in which case we will purchase BX tools and casing, and solve at least the greater part of the trouble. If this request is denied, and if we are to continue the contract, we must purchase one or

more special large sizes of core barrels, bits, and casing, which, owing to the larger diameter of the hole, would offer greater difficulty in flushing sludge from the hole. Further, the higher cost of larger tools would raise the total footage cost above the allowed rate of $7.80 per foot.

Our operating costs on the diamond drilling to the end of September equal $7.70 per NX foot, without allowance for the following items: depreciation on equipment, replacement of lost equipment, preparation of samples for shipment to the government and to our laboratory, or for the additional operating time that would have been required if we had been able to recover and handle sludge samples.

The use of BX equipment will improve performance, but I cannot see a possible reduction in footage cost. Furthermore, the recovery of sludge within the zone of weathering will remain erratic owing to the fact that an open seam or high porosity encountered by the coring bit has had its influence on sludge recovery before the trouble can be cased off. The use of BX equipment, however, will have a decidedly good effect on both drilling and sludge recovery below the zone of weathering.

Your favorable action on this request at the earliest possible date is desired in the best interests of the exploration, so that we may be permitted to bill the government for BX as well as NX work. As we interpret the contract, we may not bill you for non-coring footage no matter how it is drilled.

Yours very truly,

FOOTE MINERAL CO.

T. L. Kesler

T. L. Kesler,
Chief Geologist

TLK:br

CC: F. B. Shay
Paoli, Pa.

B. F. Buie
R.F.D. 5
Columbia, S.C.

L. G. Bliss
18 W. Chelten Ave.
Philadelphia, Pa.

C
O
P
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October 8, 1953

C
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INTERIM REPORT (2)
IMEA Docket No. 2841, Idm-E 523
FOOTE MINERAL Co.
(Columbium-Tantalum, Berly & Tin)

The exploration project being conducted by Foote Mineral Company, of 18 Chelten Ave., Philadelphia, Pa., on the Company's leases located approximately 4 miles southwest of Kings Mountain, N. C., was examined by B. F. Buie, representing the Geological Survey, on September 25, 1953. Only Tract 4 of the lease was visited at this time, as all exploration work done since the preceeding examination, on September 2, was on Tract 4.

The exploration work appears to be in conformity with the terms of the contract, except that sludge samples had not been recovered from all holes. The driller reported that it had been impossible to get return circulation in some portions of the drilling.

Summary of results since previous visit:
Hole No. 3 (Hole 4-2-1), which had been drilling at 37.8 ft. at time of preceeding visit, had been continued to a total depth of 67.4 ft. reached on Sept. 4, 1953. Pegmatite was encountered only between 8.0 ft. and 17.6 ft; only about 0.5 ft. of core was recovered from this zone.

Hole No. 4 (Hole 4-3-1) drilling was begun Sept. 10. Completed Sept. 23. Pegmatite was encountered at depth of:

20.9 to 26.7 feet.	(weathered pegmatite)	
41.7 to 61.8 "	"	"
61.8 to 69.7 "	fresh	"
71.5 to 88.9 "	"	"
93.1 to 97.2	"	"
100.9 to 103.1	"	"

Total depth 103.1

The core from this hole contains a conspecious amount of spodumene, but no unusual amount of dark minerals. No beryl was recognized.

Hole No. 5 (Hole 4-3-2) has been drilled to approximately 30 ft. Casing had been set in preparation to start coring.

Concerning the assaying of cores from the several holes, conclusions were as follows:

Hole No. 1 (Hole 4-1-1) Nothing to assay.
Hole No. 2 (Hole 4-1-2) All country rock, Nothing to assay.
Hole No. 3 (Hole 4-2-1) Core recovered from pegmatite is less than 0.5 ft. between 8.0 and 17.6 feet. No assay of core to be made.
Hole No. 4 (Hole 4-3-1) It was agreed that seven assays would be made on the various sections of core from this hole.

The cores had been carefully boxed, but were not as clearly labeled as would be desired. Mr. Kesler said this would be remedied.

It is hereby recommended that:

(1) The company be requested to take steps to obtains better recovery of core, or at least to improve the drilling technique so that a complete set of sludge samples will be available where core is not recovered.

(2) The Company be permitted to reduce the size of hole to BX where the water circulation and recovery of core can be improved thereby. This will require amendment of the contract.

s/ B. F. Buie, Geologist (W.A.E.)
U. S. Geological Survey

October 8, 1953

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

Columbia, S. C.
September 13, 1953

INTERIM REPORT
DMEA Docket No. 2841
(Columbium-Tantalum, Beryl and Tin)

On September 2, 1953 the exploration project being conducted by Foote Mineral Company, of 18 W. Chelten Ave., Philadelphia. Pa., on Tract No. 3 and Tract No. 4 of that Company's leases, located approximately four miles southwest of Kings Mountain, N. C., was examined by Wm. A. Beck, representing the Bureau of Mines, and B. F. Buie, representing the Geological Survey, accompanied by T. L. Kesler, representing the Foote Mineral Co. Examination was made of the sites being drilled on Tract No. 4 and of sites of proposed drilling and trenching on Tract No. 3.

The exploration work appears to be in conformity with the terms of the Contract, No. IDM-E525. As a result of discussion during this visit the Company's plan of proposed trenching was modified to include one of the mica-bearing pegmatites. Work completed on Sep. 2 consisted of construction of access road in Tract No. 3, and drilling of three holes in Tract No. 4, as follows:

Hole No. 1: Drilled to 49.9 ft., lost drill shoe, abandoned.
Hole No. 2: Drilled 97.7 ft, all in country rock.
Hole No. 3: Drilling at 37.8 ft.

Drilling was started with an inexperienced crew; as the crew gains familiarity with the equipment the drilling should progress more rapidly.

It was agreed between Kesler, Beck, and Buie that for those portions of drill holes from which satisfactory core is obtained assays will be made on cores alone; and that for those portions from which satisfactory core is not obtained assays will be made on sludge samples. Assays will be run on pegmatite only, not on country rock. It was also agreed that the Operator will keep the cores available for examination by Buie as representative of the Geological Survey, for a period of two weeks after a hole has been completed and Buie has been notified. After two weeks the cores will be crushed, the resulting samples split, and assays will be run on one portion of the sample.

B. F. Buie

B. F. Buie, Geologist(W.A.E.)

July 22, 1953

Memorandum

To: Hazel Berry, Operating Committee

From: Grace L. Ault, Rare & Misc. Metals Division

Subject: Amendment to contract, and contract finalized by Region IV.

Docket No. DMEA-2841, Contract No. Idm-E523, Foote Mineral Company

Mr. Schmidt reviewed Amendment No. 2, dated July 13, 1953, and approved it.

Grace L. Ault

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
ROOM 13, POST OFFICE BLDG.
KNOXVILLE 2, TENN.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JUL 20 1953

July 17, 1953

Memorandum

To: Chairman, Operating Committee, DMEA - Washington

From: Executive Officer, DMEA - Region 7

Subject: Amendment No. 2. Foote Mineral Company, DMEA-2841, Idm-E523. Cleveland County, North Carolina

Transmitted herewith are three signed copies of the above subject Amendment. The usual distribution of the other copies has been made.

Robert A. Laurence

Robert A. Laurence

coe
7-20

RECEIVED
JUL 24 1953
GENERAL COUNSEL
DEFENSE MINERALS
ADMINISTRATION

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

July 6, 1953

Memorandum

To: Hazel Berry, Operating Committee

From: Grace L. Ault, Rare & Misc. Metals Division

Subject: Amendments to contracts

DMEA-1640, contract Idm-E207, W. F. Dunnigan
Amendment No. 1, dated June 17, 1953

DMEA-2841, contract Idm-E523, Foote Mineral Company
Amendment No. 1, dated June 19, 1953

Mr. Ellis reviewed the two amendments shown above, and approves both of them.

Grace L. Ault
Grace L. Ault

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION

~~WASHINGTON 25, D. C.~~
Room 13, Post Office Building
Knoxville 2, Tennessee

June 30, 1953

Memorandum

To: Operating Committee, DMEA, Washington, D. C.

From: Executive Officer, DMEA, Region VII

Subject: Amendment No. 1, Docket No. DMEA-2841, Idm-E523
(Columbium-tantalum-beryl and tin)
Foote Mineral Company, Cleveland County, North Carolina

Transmitted herewith are original and two signed copies of the above subject amendment. One copy was retained by the Operator, one by this office, and one forwarded to the Finance Office of this Region.

Robert A. Laurence
Robert A. Laurence
Per G

Case
67-2

700 FILE COPY
SURNAME:

Schmidt
Ellis
Martin
Hedges

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION
WASHINGTON 25, D. C.

Mr. Robert A. Laurence
Executive Officer
DMEA Field Team, Region VII
Room 13, Post Office Building
Knoxville 2, Tennessee

MAY 27 1953

Re: Docket No. DM A-2841
(Columbium-tantalum-beryl, and tin)
Foote Mineral Company
Cleveland County, North Carolina

Dear Mr. Laurence:

All copies of the contract on the captioned application have been signed by both the Government and the Operator at Washington. A copy of the contract has been delivered to the Operator. Two copies are enclosed; one of these is for your office and the other is for your Regional Finance Officer.

It is of interest that Mr. P. L. Kessler has been engaged by the Foote Mineral Company and he will be in charge of this exploration project, which he has recommended in his letter to us dated May 9, 1953. He is the author of the U.S.G.S. Bulletin 436-J "The Tin-Spodumene Belt of the Carolinas" and was the geologist assigned by the Survey to the Solvay Process Company core drilling program in 1943 and 1944.

Because of the company's excellent technical facilities and experience in exploration work in this district, as much latitude as permissible has been allowed the Operator. However, as stated in the contract, the Government retains control of the direction and extent of all work, including the sampling and assaying.

This project will involve solving certain problems as the work progresses for which there is no recognized precedent. Much may be learned from this project that could be of interest to the entire district. This contract may, therefore, be of far-reaching importance.

Sincerely yours,

W. S. Martin (GVB)
ACTING Chairman, Operating Committee

Enclosure 2

APPROVED:

J. H. Hedges (GVB)
Member, Bureau of Mines

T. P. Thayer (GVB)
Member, Geological Survey

Messrs. Robert F. Griffith, Rm. 3641A
D. M. Larrabee, Rm. G-232 GSA
Ellis
Schmidt
DMEA Field Team, Region VII

FSSchmidt/gla
5/14/53
cc to: Adm. Reading File
Operating Committee
Docket

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

May 25, 1953

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
MAY 28 1953

Mr. C. O. Mittendorf, Administrator
U.S. Dept. of the Interior,
Defense Minerals Exploration Admin.,
Washington 25, D. C.

Re: Docket No. DMEA-2841
Contract No. Idm-E523

Dear Mr. Mittendorf:

We enclose herewith duly executed copies of the above contract.

Very truly yours,

FOOTE MINERAL COMPANY

L. G. Bliss

L. G. Bliss
Vice President

lgb:h

cc
5/26

700
FILE COPY
SURNAME:

Schmidt
Ellis

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION
WASHINGTON 25, D. C.

May 20, 1953

Mr. L. S. Bliss, Vice President
Foote Mineral Company
18 West Chelten Avenue
Philadelphia, Pennsylvania

Re: Docket No. DMPA-2821
(Columbium, tantalum, beryl, tin)
Cleveland County, North Carolina
Contract No. Idm-8523

Dear Mr. Bliss:

The original and five copies of the subject contract have been signed for the Government. They are delivered to you personally as Vice President of the Foote Mineral Company in order to have them all signed for the Company in Philadelphia, Pennsylvania. After they are properly signed, the Company may retain the one marked "Operator's Copy" and return the original and four remaining copies to this office in Washington.

Sincerely yours,

C. O. Mittendorf (for)

Administrator

FSSchmidt/gla
5-19-53
cc to: Adm. Reading File
Docket
Ellis
Schmidt
DMPA Field Team, Region VII

FILE COPY
SURNAME:

Kane
Pattm

140

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

May 13, 1953

Memorandum

To: The Administrator

From: Chief Counsel N.S. in R.P.

Subject: Foote Mineral Company - Docket No. DMEA-2841

There is attached hereto, in satisfactory legal form for execution, a contract covering the above-described project, subject to the attachment of the maps referred to therein and the Owner's Consent to Lien.

/s/ A E Kane for
J. L. Hofflund
Chief Counsel

AEKane/ema
cc: Mails & Files
J. L. Hofflund
A. E. Kane
Chron.

DMEA-2841

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
MAY 11 1953

P.O. Box 431,
Morristown, Tenn.
May 9, 1953

Mr. F. Sommer Schmidt,
Defense Minerals Exploration Administration,
Room 4640, New Interior Building,
Washington 25, D. C.

Dear Mr. Schmidt:

I am writing to you with regard to the planned exploration of pegmatites by Foote Mineral Company on their Williams property at Kings Mountain, North Carolina. A tentative plan for the trenching and core drilling is shown in their Drawing No. 50001, and I understand that there may be some question about whether this work will indicate within reasonably dependable limits the content of heavy minerals and beryl.

Owing to the mode of origin of these pegmatite bodies and to the experience of Foote with the heavy minerals, I strongly believe that the minerals vary in amount among the different dikes, but that they hold roughly uniform in a single body. I believe, also, that trench or channel samples as well as core samples if NX size (2 1/8") minimum can be taken to dependably indicate the proportions of these minerals, and consequently I am in favor of the plan. Its success, like that of any other mineral exploration, would depend in part on flexibility in the precise location of trenches and holes, and in the distribution of contract footage among holes, and hence I would urge provision therefor in the arrangements.

My interest in this exploration is twofold. First, I will join the staff of Foote Mineral Company on June 1st as geologist, and would have a part in any exploration that may be set up. Second, I am the author of U.S. Geological Survey Bull. 936-J, "The tin-spodumene belt of the Carolinas," published in 1942 after two years' mapping and close study of the entire belt that includes the subject properties. In addition, I was the geologist assigned by the Survey to the Solvay Process Co. core-drilling program in 1943-44, and I personally inspected and logged all of the core in that program, and prepared the government's final report on it.

In view of my experience in the Kings Mountain area, I thought that you might be interested in my reaction to the type of exploration planned. This same experience has guided me in joining Foote, as I believe that their methods and opportunities in that area are of a high order.

Yours very truly,

Thomas L. Kesler

Thomas L. Kesler
Geologist

DMEA 2841 Foote Mineral Co 5/4/53
Schmidt

Conference with Mr. Bliss vice pres of Foote Co.

This company has hired T.J. Kesler the author of the U.S.G.S. Bulletin 936-J to take charge of this exploration project.

I have asked him to have Kesler write me that he approves this project based on diamond drilling NX holes 2 1/8 inch cores. He said Kesler was in favor of the project and he would have him write this letter to me.

Foote Co report

The Knoxville Branch of the Bureau of Mines is sending a pilot plant to Kings Mountain to put in practice the method they have worked on for the extraction of beryl. The Bureau is doing this at their own expense and it indicates that they have passed the laboratory stage in this work.

Should there be an extraction of only 50% of the beryl at $2.30 per lb and .04% BeO or $1.84 per ton with 150,000 tons of mill tails stored, would amount to half of $276,000 or $138,000 worth of BeO recovered, plus recovery from the mill at 360,000 tons per year at o.8 lbs per tonat $2.30 per lb or $1.84 per ton is $660,000 total, with 50% extraction is $330,000 worth of BeO

This is of great importance.

Foote Co.

Telephone 4/17/53

Conference with Shaw of Foote Co.
Drill NX 2 1/8" core 300' entire @ 6.10/ft
Screen, prepare oil, dry water 1.40
Volume water 9.50

Spodumene content to be commercial
due 10'-30' 22% Spod.
30'+ 18% "

The mill returns show that
Ore #25 contained .449# beryl/ton
" 8 " " 12 " "

4/23/53 gla

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

April 17, 1953

Reply to:
P. O. BOX 796
PAOLI, PA.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
APR 23 1953

Mr. F. Sommer Schmidt
Defense Minerals Exploration Administration
Room 4640, New Interior Building
Washington, D. C.

Dear Mr. Schmidt: RE: DMEA 2841 - EXPLORATION ASSISTANCE
WILLIAMS PROPERTY - TRACTS 1,2,3,4

This will confirm our various conversations concerning the actual recovery of cassiterite and columbite from the several dikes at Kings Mountain.

We have checked our mill records, and find we have no daily recorded figures. However, we do have the verbal reports of the Mill Superintendent and the Plant Manager that no sudden changes in amount of production have been noted. The containers of table concentrate are cleaned at two or three day intervals and the material dried in a small infra-red drier, packed in steel pails and sent to the warehouse. During the period December 1951 - August 1952 production averaged 0.49 pound per ton of ore milled. During this period all ore was from pegmatite No. 25. During December 1952 - March 1953 production averaged 0.12 pound per ton.with all ore coming from pegmatite No. 8. In the intervening period, results were intermediate on mixed feeds from both dikes.

We believe that these facts indicate that the heavy-mineral content is relatively uniform throughout a given dike, but does vary between different dikes.

Very truly yours,

FOOTE MINERAL COMPANY

F. B. Shay
Vice President - Production

J. E. Castle
J. E. Castle
Plant Manager

W. R. Hudspeth
W. R. Hudspeth
Mill Superintendent.

FBS:gk

cc Mr. L. G. Bliss

Bx Hole 3/31/53

Bx = 1 5/8" dia

area 2.0739 sq in

Vol per running ft 2.0739 "
12
24.8868 cu in

Permatile 175#/cu ft = .10#/cu in
1728

Assume 30' sample
30' × 24.88 cu in/ft = 746.6 cu in

Wt of 30' sample
746.6 cu in × .10 #/cu in = 50

assume .03% Cu
.05 .52
.08% × 44 = .0352 #Cu × cu in 30'

1X Rale

dia: 2 1/8"

area = 3.5466 sq in

Valpewyt 3.5466 × 12" = 42.56 cu"

Pegmatite

170 #/cu ft = 0.10 #/cu in

1728

4.256 # / running ft

20' sample: 85.00 #

Channel Dampening

3" x 4" = 12 sq in cross sect.

170#/cu ft = .10#/cu in

.0098
1728) 170.00
15552
14480

Per running ft 12" x .10 sq in
= 1.44 cu in

Wt per running ft = 1.4#

6" diameter

area = 28.27 sq in

9
3.7
27
1.2
28 sq in

Vol. / running ft. 28.27 sq in
1 ft.
33 cu. 24 cu in

Pegmatite 170#/cu ft. .10 cu in
.1768

Average 30' sample: Volume
30 × 3.40 cu in 6800 cu in

Wt. of 30' sample:
6800 cu in × .10 /cu in (680 #)

= 34#/ft.

44 #

.003

.013 2 #

.16 #

44

.006

.035 2 #

3

Ax Hole 1⅛ 3/3/59

Calculation weight of core material - core or sludge.

assume Ax 1⅛" core dia

area = .994 sq in

Vol per running ft

.994" × 12" = 11.928 cu in

Assume 20' sample

20' × 11.928 cu in = 238.56 cu in

Specific 170 lbs/cu ft = .10 #
1728 cu in

wt of 20' sample

.10 × 238.56 cu in = 24 #

Imports 1952 (Preliminary)

for consumption plus stockpile

Cb_2O_5 Equivalent	1,800,000 lbs
Beryl (10% BeO)	6,000 short tons

1952 Estimated domestic production

Cb_2O_5	6,000 lbs.
Beryl	600 short tons

Data by Robt Smith

Tracts 1-2-3 owned in fee
+ mineral rights only - defined in deeds of record

Lease 12/10/49

1st Pt Lessor L. M. Williams & wife
Ina B. "
Janie McCuxton Cole by (Attorney in fact) for Jane McCuxton Cole
Jean Cole Hatcher (Jean G. Cole)
Jean Cole Hatcher & Husband
Rube Hatcher,
Emil Cole Morris & Husband
Robert A. Morris
Frances Cole Culp & Husband
BB Culp.

2nd Pt Lessee Foote Mineral Co.

Location in N 4 Township Cleveland Co
N. Carolina Kings Mtn Dist

Application DMEA 2847 Foote Mineral Co 3/18/53
notes by Schmidt

The question as to whether a significant production might be made from these properties under discussion depends upon the following;

First; the content of the pagmatite dikes in the strategic metals.

Second; the amount of extraction that can be made in a concentrating mill.

The dikes, while tolerably uniform in themselves, vary amongst eadh other in their content of strategics; as for instance dike 25 contains 4 times the amount of strategics found in dike 8. There is therefore a justified exploration gamble that higher grade dikes than any heretofore found, might be encountered.

The Foote Co. started their mill September 1951, and have made improvements right along in the saving of columbite, cassiterite and spodumene.

The current expansion of the mill from 120,000 tons to 360,000 tons per year, and the increase in the number of spirals from 8 to 36, and the laboratory extraction of 60% of the beryl, all point to the fact that the savings of the past should not be the criterion.

It is not a question whether the savings of the present flow sheet, nor the contents of the dike now being mined make a significant impression on National needs or production. It is to find better dikes, and to determine with one modest project in this belt, whether exploration by drilling and surface channeling conducted by the best equipped organization is this belt, brings results that justify further exploration projects.

In any case, data will naturally be obtained as to the location and tonnage of Columbite, Cassiterite and Beryl.

The following table is based on a mill capacity of 360,000 tons per year on ore the equivalent of dike 25. The mineral columbite contains about 70% pentoxide and cassiterite 60% tin and beryl 10% BeO

	Present saving	Enters Mill	USA Production	USA Consuption and stockpile
Cb205	28,350 #	56,700 #	6,000 #	1,800,000#
BeO	experimental	288,000 #	120,000 #	1,200,000 #
Sn	15 Long ton	30 Long ton	22,521 Long ton	73,384 Long ton

It can be seen that while the production of the columbium pentoxide does not promise to be a very significant part of the total consumed in this country, it does promise to be a very important part of the domestic production.

The amount of beryl entering the mill is a very significant amount in comparison to the domestic, or the total USA consumption, and while no saving is attempted at this stage there is every reason to think that there soon will be more or less of a solution to this metallurgical problem.

The tin possibilities are the least favorable, especially since the world is at present producing about 30,000 tons a year more than is being consumed, and the price may likely be reduced.

No stress is laid on the spodumene, though there is a 70% certificate of necessity by DMPA for mining spodumene at Kings Mountain by the Foote Co. and certainly the production of spodumene is not only subject to the royalty, but also has a market through the Foote lithium salts chemical plant. There does not appear to be any surplus prodution of spodumene in the foreseeable future.

It would appaear that since there is a chance of getting better ore than any that present calculations are based on, that DMEA owes it to itself to at least do some exploration work on this belt on a project involving Government participation of only $24,156.00 on a 90% basis.

NOTES ON NORTH CAROLINA SPODUMENE BELT

by

F. Sommer Schmidt

3/10/53 3/13/53

Applications:	Lincoln Mining Corp.	DMEA-2773	Sn	Cb-Ta	BeO
	Foote Mineral Co.	DMEA-2841	"	"	"

The pegmatite, spodumene belt of North Carolina is approximately 25 miles long by 1.8 miles wide. It has been known for many years, especially for the lithium content. The present importance is due to the strategic tin, columbite, cassiterite and beryl, to be called the strategics in the following:

Different dikes vary in their content of these strategics, but any given dike is tolerably homogeneous. The literature has been dominated by USGS Bulletin 936-J by Kesler written in 1942 at which time data recently obtained were not available. Present practical experience contradicts some of the conclusions of Kesler who was looking at these pegmatites from an entirely different viewpoint. There is little in this Kesler bulletin that is of help today.

This belt is the largest repository of these strategic ores in this country. Based on the mining of over 150,000 tones of this ore by open pit the Foote Minerals Co. reports the average grade of the ore mined from 4 different dikes as follows:

	%
Spodumene	15%-20% containing 6% Li2O value $15.00 per unit
Columbite-tantalite	.03
Cassiterite	.03 -.05
Mica	3.0
Feldspar	45.
Beryl	0.4
Quartz	30%-40%

The total amount of strategics in the ore is not the main consideration. It is the amount that can be extracted.

While the mineral spodumene is not on the strategic list of the DMEA the Foote Co. has a 70% certificate of necessity from DMPA for mining spodumene at Kings Mountain. This permits amortization of 70% of capital expenditures in that operation to be amortized in 5 years instead of the normal approximate average of 10 years and certainly recognizes the importance of spodumene production.

The value of the spodumene makes it possible for the Foote Co. to produce the strategics. It will probably be necessary in the foreseeable future to mine spodumene at a profit in order to produce the strategics. This immediately raises the question whether we are primarily interested in exploring for the strategic metals and setting aside

speculative considerations as to whether there is going to be a market for the lithium in years to come. It would seem to be our primary concern to explore for the strategics in order to inventory them against the day when they are needed at any price.

This data is to help determine whether DMEA should establish a policy of exploring these pegmatites, for there are two applications under consideration at present with the likelihood of there being others. The decision may therefore be far reaching, but it will involve only exploration and not production.

The main objections to participating in this exploration work are:

1. In order to produce an important amount of the strategics it will be necessary to produce more lithium than the anticipated market will absorb, and in that way prevent their production.

It is not our business to figure on what may be the demand or the price of lithium, nor the demand for these strategics in future years. We are interested in knowing where the strategics are. It is our field to determine which dikes will produce the most strategics as a by-product of the spodumene. It is self evident that dikes containing the most by-products will be mined in preference to others, and some dikes contain more strategics than others, contrary to the geological writings or assumptions of the past. Foote Co. dike No. 25 contains almost 4 times as much columbite and cassiterite as dike No. 8. To show that substantial amounts of these strategics are involved the Foote Co. which its expanded mill of 360,000 tons per year capacity would produce from dike 25 in 1 year 40,500 lbs. of Columbite value $119,000 and 56,520 lbs. of cassiterite value $39,300. This is based on the present 50% mill recovery. The company has sold between Oct. 13, 1952 and Jan. 21, 1952 Columbite 8,765 lbs. and cassiterite 16,250 lbs. The present mill recovery of the stratetics should be improved by increase of Humphrey spirals from 8 to 36 now being installed. The strategics are concentrated in the spirals.

2. It is claimed that in pegmatite dikes, minerals are usually distributed in a banded or zonal structure, therefore a drill hole in such a formation would give erratic and unreliable results, and futthermore the amount of material obtained from a diamond drill hole is too small to permit an accurate determination.

There is a difference between at least some of the pegmatite dikes of North Carolina and the Belgian Congo and South Africa on one hand, and the conventional pegmatite dikes on the other. There is abundant evidence provided by the Foote Co. in North Carolina and the Geomines (tin) in the Congo and the UIS tin mine in South Africa that the mineralization

in their pegmatite dikes is sufficiently disseminated with such uniformity as to make diamond drilling a satisfactory manner of exploration. This data has been obtained from actual experience with diamond drilling followed by mining. The operators claim their diamond drilling has been justified in all three of these instances.

It would appear from the foregoing that the main objections to the drilling exploration of these dikes are not sufficiently valid to justify a denial of these applications. It is of interest to note that the objections raised are mainly from commentators who have not examined the property nor the district.

It is fortunate that these pegmatite dikes in North Carolina vary considerably in content of strategics, which are not in constant ratio to the spodumene. It should therefore be possible to explore for "high grade" and possibly find a dike which contains more strategics than any dike heretofore explored. This condition creates an exploration incentive. The exploration work would not be confined to diamond drilling but include channeling of the outcrop of dikes or such exposures as would be made by bulldozer. The point at issue is whether exploration is warranted at all on the dikes in this belt, with the details of the drilling and channeling or churn drilling to be worked out in each application.

There has been enough basis for the above conclusions in the 24,000 tons per day operation at Geomines, and the 370 tons per day of the present Foote Mill all of which production is being made from pegmatite dikes that have been drilled, to take this whole subject out of the realm of geological speculation, and put it in the category of practical business.

Detailed notes from which the foregoing conclusions were derived accompany this summary.

RECOMMENDATIONS

The subject applications should receive favorable consideration as a matter of policy, but the details of the applications should be carefully analyzed and contracts be made suitable to our own ideas.

This should apply to other applications in this belt wherever the applicant appears to be competent to carry on this work, which is very technical, because of the small percentage of strategics involved, and the unusual and unfamiliar character of the strategic minerals. Core drilling or churn drilling or sampling of trenches or underground sampling and the subsequent treatment of these samples should be done only by operators equipped to make the proper determinations and interpretations.

Since the royalty payments will be made from the value of the ore including the spodumene the total loan will be paid back very rapidly provided that the mining will be done from the dikes explored by this project. In the event that the spodumene concentrates are treated by a chemical plant belonging to the operator some price must be set on the spodumene mined or the concentrates shipped to the chemical plant. A price must be established for the spodumene in order to collect royalty.

The matter should be explored as to whether some other percentage of participation on the part of the Government should be used where the spodumene is not on the DMEA strategic list but the cassiterite and columbite and beryl are on the list of 90%. It is quite conceivable that the operators would be willing to accept a 75% participation on the part of the Government, but it remains to be decided whether this could be done legally.

COMMODITY COMMITTEE COMMENTS ON
APPLICATIONS

Lincoln Mining Company, Docket No. DMEA-2773

Erwin Lyons, Geological Survey, January 27, 1953

"Application is denied on basis that principal product would be spodumene and that there would not be significant production of tin and columbite as by-products."

Wallace Griffitts, Geological Survey, January 6, 1953

He recently completed geological survey of the belt and is familiar with Foote operations.
"If each hole were moved to the west side I would see nothing wrong with the drilling proposal, I don't believe that there is need to worry about the operators failing to recover cassiterite and columbite in any mill that might be constructed as suggested by Lyons and Kinkel."

Erwin Lyons and A. R. Kinkel, Geological Survey, December 10, 1952

Page 2 - "As the deposit has been carefully mapped by the Survey Bulletin 936-J it seems doubtful that a new field examination would add additional information. We recommend that the application be denied for the following reasons." Then comes 4 reasons, none of which are valid for purpose of denial. This report misses the point entirely and bases everything on a bulletin 11 years old, now obsolete. This report expresses some erroneous ideas.

Joseph Arundale, Bureau of Mines, December 4, 1952

"If in aggregation the quantities of cassiterite, columbite-tantalite and potentially beryl that might be made available are significant, then the application should be considered." His personal expression is that he hopes we can justify the exploration.

Abbott Renick, Bureau of Mines, November 18, 1952

Adds nothing and passes decision to Arundale.

Foote Company, Docket No. DMEA-2547

Paul Weis, Geological Survey, January 14, 1952

"Available data indicate that the average grade of columbite and tantalite and cassiterite can be expected to remain fairly constant throughout these pegmatites." The fact is the Foote dike 25 has almost 4 times as much of these minerals as dike 8 which data has been derived from mining 150,000 tons.

He considers the drilling as development instead of exploration.

"It appears likely that applicant will continue to mine the pegmatites for spodumene regardless of what action is taken on this application." This is mistaken idea, the applicant will mine on such dikes as have been proven by exploration to have the most strategic by-products. Weis is dominated by the obsolete Bulletin 936-J instead of recent actual practical experience.

A. Kauffman, Bureau of Mines, July 9, 1952

"The applicant claims that about 10 tons (of the strategics) could be produced annually which is an appreciable contribution to the supply of these strategic and critical materials." The figures by Foote are that with expanded mill to 360,000 tons annual capacity and the present 50% extraction the pentoxide saving would be 28,350 lbs. and 33,900 lbs. of tin from dike 25.

Foote Company, Docket No. DMEA-2841

James Norton, Geological Survey, March 5, 1953

He personally told Chambers, President of Foote Company that he did not see how his most recent application could be accepted in the form in which he last saw it. Wants documentation to prove what is actually going on.

James Norton, Geological Survey, January 26, 1953

"Inasmuch as the final decision of DMEA-2547 was to deny the application I think that this application also has to be denied." He considers project development. "The chief purpose would be to outline spodumene reserves. Tin, tantalum and columbium would be by-products that would depend on spodumene production just as in DMEA-2547." "The beryl cannot be profitably recovered by any method now known." Both the Bureau and the Foote Company have gotten 60% extraction in their laboratories and the potentialities are very great. He misses the point entirely that this exploration is to find dikes with higher content of strategics (compare

dikes 8 and 25.)

Robert Griffith, Bureau of Mines, January 13, 1953

"In view of the potential production of short supply commodities from the subject property this office recommends that the subject application be viewed favorably."

Detailed Notes by Schmidt 3/13/53

One of the reasons for considering these applications as of unusual importance is shown by the following quotation from W. Griffitts, Geological Survey, January 6, 1953 who has recently made an examination of this belt. "It should be borne in mind that the Consolidated Feldspar Corp., the Lithium Corp. of America, Commercial Ores Inc., Mathieson Chemical Corp. and Fletcher Phillips have also shown interest in the spodumene deposits.

The Foote Company has worked 4 pegmatite dikes Nos. 25-18-21 and 8. The concentrating mill has a capacity of 370 tons per day or 10,000 tons per month. The mill has been in operation since Sept. 1951, and treated 150,00 tons of ore to January 1, 1953. During 1953 at a cost of $380,000 the mill will be enlarged to three times its present capacity or to 30,000 tons per month. The number of Humphrey spirals will be increased from 8 to 36 not only to increase the capacity, but also the percentage of saving of the strategics.

The company is building a $4,000,000 chemical plant to make Li 2 Co 3 and Li OH H20 at Sunbright near Kingsport, Va. DMPA has given the company an 80% certificate of necessity for manufacture of Lithium salts and a 70% certificate of necessity for the mining of spodumene ore at Kings Mountain, North Carolina.

The mill crushes to 40 mesh, then spirals. The "Heavies" are the spiral concentrates 25% columbite and 35% cassiterite. They are treated on Wilfley tables where more gangue is separated. The "Heavies" concentrates are treated magnetically to separate the columbite from the cassiterite. The tails from the spirals are floated, and the spodumene is floated off. At present the Beryl is not saved, except in the tailings pond now containing 150,000 tons, which will be retreated when further metallurgical advances are made. It is planned to save the Beryl as a result of experimental work by the Bureau of Mines and also the Foote Co. laboratories. As much as 60% saving has been made in experimental work in both these laboratories. The extraction of the spodumene and columbite and cassiterite is over 50%, but with the additional spirals this should be improved. There is difficulty in determining the percentage of extraction when assaying such minute percentages in the mill heads.

With the enlarged mill of 30,000 tons per month capacity, th amount of Beryl that enters the mill will be 2,800,000 lbs. per year, based on .4% Beryl. What the extraction and concentration of beryl will be is not known at this time, but there is no other place in this country where a greater effort is being made by the Government (Bureau Of Mines) to solve this metallurgical problem.

The lithium mineral spodumene will pay the expenses of the operation that produces the Cb and Sn, and any possible BeO. Lithium salts have been given 80% certificate of necessity by DMPA, and the mining of spodumene at Kings Mountain by the Foote Co. has been given a certificate of necessity of 70%.

Assuming that no value is to be given to the lithium mineral spodumene, the company states that the enlarged plant, 360,000 tons per year, should produce during the next year the following, based on the same rate of extraction as the present mill, with production from the equivalent of Dike 25.

Columbite 40,500 lbs at 70% pentoxide at $4.20 per lb.	$119,000.
Cassiterite 56,520 lbs at 60% tin at $1.16 per lb.	39,300.
Total	$158,300.

The mill extraction with 36 new additional spirals should be better than with the present 8. Actual production to date shipped between October 13, 1952 and January 21, 1953 plus some undetermined small tonnage on hand.

Columbite 8,765 lbs average 70% pentoxide	$25,281.54
Cassiterite 16,250 lbs average 60.67%	10,680.49
Total	$35,962.03

It has been found from mining on 4 dikes, that the mineralization is sufficiently uniform throughout a dike, so that the values of ore mined checks with the values shown by the drilling. This checks with the experience of the Geomines of the Congo, and the UIS Tin mine of South Africa and with the Val d 'Or pegmatites of Quebec (see Arundale Minor Nonmetals 1950 p 8). This is important for our purpose in appraising these applications. The weathering extends down 20 to 30 feet, which militates against saving of spodumene, though not of the strategics. There are 4 types of ore treated by the Foote mill; the weathered ore with or without iron stain, and the solid unweathered ore with or without iron stain. The most amendable is the unweathered and unstained. The mill treatment must be adapted to each one of these types, and in accomplishing this the Foote Co. has pioneered an important step forward.

Pegmatite 8 which is 600 ft. wide and $\frac{1}{4}$ miles long is now being mined by open pit with power shovel and trucks. There is 15 years supply of ore in sight for the enlarged mill. The Foote Co. can continue to mine and mill this ore for their Sunbright lithium chemical plant, but if they knew of another dike that contained the same amount of spodumene together with more Cb and Sn and BeO they would mine and mill that ore, because of the greater value of these by-products. It is for

the purpose of finding such another dike with higher percentages of the strategics that this exploration program is proposed. In other words if the Government wants these stratetics, the best way to get them is to participate in the cost of finding them.

It is necessary to consider that the metallurgy of this ore is in its infancy. The figures of past production include the first stages of mill operation. While this belt has been known for many years such operations as the Solvay Co. conducted on this same property as recently as the last war, bore no resemblance to the present operations. No attempt was made to do any concentrating of the strategics though the spodumene was floated to some extent.

The Foote operation is a thoroughly intergrated one from the pegmatite ore to the refined lithium salt. In the repayment of the loan by royalty the value of spodumene must be included. The value of the ore based on the present mill extraction and of the composition of Pegmatite 25 is as follows:

	Per Ton
Spodumene 20%-lithia 1.0% extracted 0.7% unit price of lithia $10	$7.00
Columbite .224 lbs. per ton extracted .112 lbs per ton 70% pentoxide at $4.20 per lb.	.33
Cassiterite .315 lbs. per ton extracted .157 lbs. per ton 60% tin at $1.16 per lb.	.11
Total value recovered	$7.44

Very doubtful

The royalty at 5% on the expanded mill capacity of 1,000 tons per day would be $370 per day which would require only 65 days to pay off the $24,156.00 of Government participation.

This is based on the idea that the production will be made from the dikes explored by this project. The operator is not forced to mine from those dikes. If the exploration is successful it will be to his interest to do so. This is the chance we take. If the exploration is not successful, it must be charged to getting information concerning the location of strategics.

In the case of the Foote Co. the spodumene concentrate is treated in their own chemical plant. Therefore a price must be put on the spodumene or the concentrate on which to base the royalty.

Geomines Belgian Congo

Engineering and Mining Journal Nov 1952 page 86 by Barzin General Manager

"The cassiterite is distributed uniformly in the pegmatitic mass in relatively small grains. More than half are less than 0.5 mm in size"

There is no comment on the uniform distribution of the columbite but since the cassiterite is uniformly distributed ~~and~~ the probability is that this also applies to the columbite, and in any case this unfiorm distribution of the tin seems to contradict the idea that pegmatites must have zonal or banded distribution of the mineral. The ore contains cassiterite 2 lbs per ton and columbite .13 lbs per ton.

Mining World Nov 1952 p 32 by Lyons Prof Sydney Tech College

Geomines will treat 24,000 tons of tin ore per day.

"Since 1933 the softer, kaolinized, near surface soft pegmatites have been mined and washed, Since 1946 exploration by drilling below the soft ores at Kitotolo disclosed the existence of continuous primary ore of higher grade, than the near srface ores. This was of great significance as the harder ore is much more difficult and costly to mine and wash etc."

This indicates that the ~~kind~~ tin values at the surface can be either leached or carried off mechanically. Hence the tin values of the outcrops ~~do~~ may not do justice to the pegmatite possibilities.

"Cassiterite is the principal tin mineral, and is disseninated almost homogeneously in the primary rock." grade is fairly uniform to a depth of 350 feet at least.

the ore runs 4.5 to 5.5 lbs of tine per yard. This checks against the 2 lbs per ton in the article in the E and M J. Spodumene is an important constituent of the pegmatite, and plans have been considered for production of lithium. See this article for analysis of concentrates both general, and also columbite and tantalite concentrates.

~~Conference with Chas. Mitke 2/25/53 U I S tin Mine South Africa~~

He observed the diamond drilling at the Geomines, and found that the mineralization in the dikes was sufficiently uniform to permit the use of diamond drills. There is sometimes a certain amount of higher grade ore at the contact of the pegmatite dikes and the shist walls, which however is only 2 to 3 feet thick, which is a very small proportion of the total wideth of the dike.

The diamond drilling was done by German engineers and Mitke found from them that the tin 6 lbs per ton at 400 ft level, was the same as at the surface and that this diamond drilling was found dependable. However the Geomines has supplemented the diamond drilling by churn drilling 9 inch holes. Mitke concludes that in pegmatites of this kind, where the distribution of the heavies is quite uniform, that drilling by diamond drill and especially if followed by 9 inch churn drill holes, gives excellent results. The Geomines has checked the diamond drilling by both the churn drill holes and also by mining and the results have checked sufficiently well to justify the diamond drill as a satisfactory method of prospecting. This point was covered thoroughly with Mitke who has the UIS tin mine in South Africa where he proposed to drill his pegmatite dikes.

Lithium

Arundale page 4 Extracts from latest paper by Arundale BM undated

"Measured reserves appear to be relatively small, when compared with projected demand, but the numerous deposits mentioned above have not been thoroughly explored. Geologists and company officials agree that domestic reserves will prove to be in reality very large."

The Geological Survey reports indicated reserves of ore in two areas of the Kings Mountain district at more than 2,250,000 tons averaging over 1.7 % lithia and containing approximately 80,000,000 pounds of lithia. Actual reserves in this district probably are much greater and may amount to hundreds of millions of units of lithia. Known deposits in the Black Hills probably contain many hundreds of thousands of units.

Page 10 One of the uses referred to "various more or less secret requirements, including a significant requirement for the Atomic Energy Program"

Page 140 data from NPA and DMPA current capacity 4,000,000 lbs of lithium carbonate equivalent with current requirement of 6,000,000 lbs leaving a deficit in supply. Anticipated requirements by 1955 estimated at more than 10,000,000 lbs of lithium carbonate equivalent. or this tonnage about 50,000 tons of 5% spodumene equivalent will be required.

Same page under problems "Most lithium compoundz are relatively high cost materials and this undoubtedly is a deterrent to their wider utilization. Reduction of these costs is an objective of research by both industry and government" End quote

This would indicate that if dikes containing more of the heavies could be found, that these by-products would help to reduce the cost of lithium compounds.

The American Potash Co makes lithium carbonate It is made as a by product of the lithium sodium phosphate 20% Li2O which is a by product of making borax and its production is geared to the manufacture of Borax. The total possible production is 1,500,000 lbs carbonate. Limit imposed by borax production. (data by Foote Co) who formerly bought the entire output.
the current requirements are 6,000,000 lbs. anticipated requirements by 1955 is over 10,000,000 lbs of carbonate equivalent

EA-2841 Foote Mineral Co.

Notes on memo by Norton Geological Survey dared 4/8/53 By Schmidt

(1) Mr. Schmidt stated that he wanted no more information from Government sources than he already had." I told him that I was not interested in any geological reports that did not take into consideration the work the Foote people had done, and that in so far as his repors were based on this recent modern experience I was most anxious to get them because their experience in mining 150 tons and sinking pits 100 feet deep, in the pegmatites had given data that contradicted the published reports of 10 years ago. It can be seen from Griffits memo to Norton accompanying just why I must take this position.. Griffits says the spotty distribution of both cassiterite and columbite etc. This is all based on geology work at the North end of the belt at the Ka-Mi-tin mine and writings of the past and is contradicted by the results of the milling of the Foote Co. on which this project is based.

(2) "A decision must be made as to whether the recoverable tin etc." That is exactly what the exploration project is all about. I wish we knew. How can we tell without doing this exploration.

All thru these memos of Norton and Griffits there runs the theme song that these dikes all run about the same in heavies, and that the mineral is bunchy. This is all based onthe old literature and they cannot seem to bring themselves up to date. If we did not have evidence to the contrary there would be no use in this project.

(3) There is mill data to show the uniformity of the distribution of the minerals. This is not in the geology books. There is also data to show that dike 25 had 4 times as much heavy minerals as dike 8. We are now planning to find one that has 4 times as much mineralization as dike 25 . Since they vary as they do, it is hoped that our exploration which is to be on favorable dikes as shown by some preliminary tests may prove to be higher grade than anythingmined in the past. Mill now being enlarged to 1100 tons.

(4) It is not inconsistent for the strategic minerals to vary as they do. These dikes vary and dike 25 yields 4 times as much heavies as dike 8 therefore when mining dike 25 they got different results than when mining dike 3. It is that simple. There is nothing embarressing about these questions. The crude ore simply varies. The flow sheet did not change nor the capacity of the mill.

(5) Determine whether the grade and reserves of spodumene are adequate for profitable mining. That is the object of this project, though the cost of assaying for Li is not in the project.

(6) See notes from conference with Dr. Fleischer of the Survey the authority on spectographic analysis. The project contemplates channeling the outcrops of dikes for sampling and also for concentrating the samples and spectographic analysis of the concentrates. Norton recommends the 4 X 4 trenches thru solid pegmatite. Unpractical. Cost would be about $10. per foot.

4/10/52 gla

IN REPLY REFER TO:

G-MD-CNM

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
APR 9 1953

Memorandum April 8, 1953

To: E. W. Ellis, Defense Minerals Exploration Administration

From: J. J. Norton, U. S. Geological Survey

Subject: Foote Mineral Company application, DMEA-2841 (columbite, tantalite, tin, beryl)

This memorandum contains a further statement of our opinions regarding the Foote Mineral Company application DMEA-2841 (columbite, tantalite, tin, and beryl). You received a copy of my letter of March 5 to W. R. Griffitts. A copy of the pertinent parts of his reply is attached. My telephone call to Mr. Schmitt on March 20 was for the purpose of discussing Griffitts' letter. At that time, however, Mr. Schmidt stated that he wanted no more information from Government sources than he already had. Nevertheless, I am submitting this memorandum together with Griffitts statement for inclusion in the docket, in the event that someone will have use for them.

Griffitts' letter shows what he thinks should be done if DMEA decides to participate in exploration of this property. Two preliminary steps are necessary, however, before Griffitts' suggestions can be considered:

1) A decision must be made as to whether or not the proportion of recoverable tin and columbium is high enough to justify DMEA exploration of pegmatites in the tin-spodumene belt.

2) The applicant should provide complete evidence to show whether the range in tin-columbite content from one place to another is great enough to indicate that DMEA exploration will obtain useful results. This applicant has told me that the heavy mineral production has ranged from 600 to 6,000 lbs. in a month, and about 10,000 tons of rock is mined monthly. Last summer, however, under DMEA-2547, this same applicant supplied production data that indicated a content of .4 to .64 lbs. of cassiterite and .26 to .41 lbs. of columbite per ton of ore. These figures show that the maximum possible range is 6,600 to 10,500 lbs. of cassiterite and columbite in 10,000 tons of ore. Figures submitted previously were even higher.

.4 — .64
.26 .41
.66 1.05
10,000 T 6600# do
10500#

I think it is evident that comprehensive documentation is needed to show the range in content of heavy minerals. Otherwise such embarrassing

questions as the following can arise:

(a) Why do applicant's figures seem so inconsistent?

(b) Was the same quantity of rock mined during the month when 6,000 lbs. of heavy concentrates were produced as during the month when only 600 lbs. were produced?

(c) Was the mill circuit the same during the months when the extreme values were obtained, or is there a possibility that there may have been a higher loss of heavy minerals in the mill at one time than at another?

If DMEA explores pegmatites of this district, Griffitts suggests essentially the following procedure:

1. Determine whether the grade and reserves of spodumene are adequate for profitable mining. This work would be limited to finding whether the deposit is good enough to warrant consideration as a source of by-product columbite and cassiterite. Doubtless the applicant would later have to do a large amount of additional work to obtain detailed data on the deposit prior to mining, but such work would be of no concern to DMEA.

2. The tin-columbite content would be determined by collecting large surface samples. Drill hole samples probably would not be large enough. Griffitts recommends that the samples be collected by closely spaced trenches. He also suggests the possibility of collecting many small samples on a 1 or 2 ft. grid, but I think that the trench method is better because it is more practicable and can be controlled more readily. Griffitts recommends that the cassiterite-columbite content be determined by concentrating the heavy minerals rather than by assaying. I suggest that assays be used in addition as a control on the heavy mineral separations.

J. J. Norton

3/27/53 gla

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
MAR 26 1953

March 25, 1953

Mr. F. Sommer Schmidt,
Defense Minerals Economic Admin.,
Room 4640,
New Interior Bldg.,
Washington, D. C.

RE: Docket DMEA-2841

Dear Sommer:

In answer to your questions dictated to my secretary over the telephone March 19th, we give you the following information:

1 - What is this channelling that takes one man hour per foot? How is it to be done? By hand or by machine? How deep is the channel and how wide? What takes one hour to make a foot?

A - Channelling in these surface exposures requires cleaning and brooming of earth and soil from the area to be sampled. The channel is cut with a moil and should be about 4" wide and 3 to 4 inches deep. The time allocated includes travel time, cleaning of the trench, bagging and tagging of samples, crushing and quartering of samples. The actual cutting of the channel will probably require from 1/3 to 1/2 manhour per foot.

You will appreciate from the above that we are estimating that the preparation for channelling will require the time difference between the 1/3 to 1/2 manhour per foot in actually cutting the channel and preparing for the channel.

2 - Assaying should be done in Foote laboratory and the cost of these determinations is too high on that basis. Regular charges for one sample of the following are:

CbO	$ 15.00
Tin	7.50
BeO	5.00

Penniman & Browne
DE 7-5066

with considerable reduction in quantities such as this job.

A - We have not made a definite decision as yet as to whether we would do all the assaying work on the samples derived from the core drilling and the channelling and have obtained a quotation from Booth, Garrett and Blair of Philadelphia, recognized umpires and assayors, on March 20, 1953 based on 200 samples to be delivered all at the same time, at a cost of $27.00 per sample, exclusive of Beryllium. We therefore believe that our cost estimate is very much in line.

Mr. F. Sommer Schmidt
Defense Minerals Economic Admin. March 25, 1953

3 - From past experience how many feet of drill hole will be used for a sample? What size drill hole has been used successfully in the past? The size of the drill hole must take into consideration that a sample of the core must be provided to the Government. Therefore, what size is contemplated under that condition?

A - On recent drilling we have used 10 foot intervals. However, this must be correlated with the geology and shorter intervals are composited where only a portion of the 10 feet is in pegmatite. AX core has been used except in the softer upper portions where BX core was drilled to provide for casing.

Bx 1 5/8
Ax 1 1/8
Ex 7/8

When we made our exploration proposal we were not aware of the fact that the Government looked at exploration contracts as grants. Actually, we believe it to be a loan. The analyses of the cores therefore, should represent confidential information. It had been our intention to split the cores in half and retain one-half at Kings Mountain for a permanent record. We did not know that it was necessary to provide the Government with a portion of the core. However, this matter could be resolved to both parties satisfaction I am certain.

4 - We may ultimately decide that some 9" churn drill holes be sunk in order to get enough material and better samples. What is your reaction to this? What would be the cost per foot in that section for churn drilling? This would probably be done after the diamond drilling determined the dip of the dikes.

A - It is our opinion that churn drilling would be very expensive. We do not know of any comparable experience except at Geomines in the Belgian Congo. In this case 9" churn drills would only drill about 12" to 15" before resharpening.

5 - How was the estimate of 200 samples arrived at? This is not questioned but is being asked for information.

A - The estimate was based on 100 to 120 samples from 2100' of diamond drilling and 80 to 100 samples from 2140' of channelling.

6 - Explain rental of bulldozer. Is it to prepare sites for the drills or is it to remove overburden from the dikes so that they can be channel sampled?

A - The bulldozer is needed to remove overburden for channel sampling and to delineate contacts to make sure of drill hole and channel locations.

Mr. F. Sommer Schmidt
Defense Minerals Economic Admin.

March 25, 1953

We sincerely trust that we have given you all the information you require and again thank you very much for your prompt attention to our request.

I understand that you will advise us when you require a representative from our Company in Washington to discuss this matter further.

Very truly yours,

FOOTE MINERAL COMPANY

Tony

L. G. Bliss
Vice President

lgb:h

DMEA-2841 FOOTE MINERALS CO.

Notes on Memo by Griffit's Geological Survey to Norton of 3/11/53

By Schmidt

(1) "The spotty distribution of both cassiterite and columbite in the pegmamtites stc." There is no spotty distribution at the south end of the belt in the Foote operation, and this is exactly what I meant when I told Norton that I was not interested in any geology that did not take recognition of what had been learned by the mining of 150,000 tons in open pits on several dikes. Pilot plant very unpractical - not nexessary - see spectrographicnotes from Fleischer of the Survey and his publication 225 Columbite contents vary as much as from 600 to 6,000 tons in 10,000 tons of rock this is undoubtedly a typographical error meaning lbs instead of tons.

I

(2) The geological conditions at the N. end have definite veins of high grade tin. This is unknown at Kings Mtn. Griffits ideas are based on the Ka-Mi-tin conditions.

For the project in mind undergronnd samples are useless.

The depth of 200 ft may not apply. The depth to which practical mining in open pit can go is the criterion, and is usually not much over 100 ft. Also data concerning the first 100 ft. would probably apply to the next 50 ft.

(3) Certify a discovery even if no Cb is found. - Sorry we cannot certify spodumene discovery.

(4) Unpractical - Impossible to estimate the Cb and Be etc content by inspection of evalute the possibilities of mining rock of THAT composition. What composition?

(5) If spodumene is found on the outcrop etc. Found How? That is part of this project namely cutting channels in the outcrops for sampling.

(6) If dike dows not persist to 200 ft. depth discontinue. - Not right - Depends on feasible depth for open pit and 200 ft. is too much for no most of these dikes.

(7) If drilling proves dike tonnage and spodunene content to be adequate then trench the surface after the drilling. The cart before the horse.

If drilling is done we can get good idea of Cb and Be, Sn content from cores. spectographically. Proposal to cut trenches 4"X4" thru solid rock is unpractical! Cost $10.00 per ft.

Again the staement "Because of spotty distribution of Cb etc" This applies to the North end and Foote experience contradicts this.

Samples to be concentrated 20 or 30:1 and heavies determined spectographically- No chemical assay of low % heavies contemplated.

(8) Now putting first things first, and reversing his original procedure. No clean out program.

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

March 11, 1953

Mr. James J. Norton
U. S. Geological Survey
Washington 25, D. C.

Re: DMEA-2841

Dear Jim:

The spotty distribution of both cassiterite and columbite in the pegmatites of the tin-spodumene belt seem to me to make sampling rather difficult unless the samples taken are numerous enough and large enough to make their treatment nearly a pilot-plant operation. I didn't realize that, in tonnages of rock as large as 10,000 tons, the columbite content would vary as much as from 600 to 6000 tons. The contents, even though the high figure is considered a freak, are high enough to indicate that "significant" amounts of columbite might be obtained as a by-product of spodumene recovery.

On Jan. 6, 1953, in a memo to Bob Laurence regarding DMEA docket 2773 on the Ka-Mi-Tin mine near Lincolnton, N. C., I commented "The cassiterite and columbite are so erratically distributed as to require an impractically large number of drill holes for reliable sampling. Bulk samples from drifts (brought up because the applicant proposed underground work) would be far better, but more expensive, and would not be justifiable unless the amount of rock present was rather large." The procedure I was plugging then was to establish by a couple of drill holes that the pegmatite dike extended to at least 200 ft. depth and that the spodumene content, which would probably be relatively uniform, was high enough to insure that the deposit could be mined. If there were insufficient tonnages or if the spodumene content were too low to permit profitable mining, I thought that there would be little point in incurring the expense of reopening a shaft, drifting, and processing the samples. I still think that some such procedure might be most effective, although I may be overestimating the expense of the sampling and assaying. This brings in a peculiar emphasis on non-strategic materials and isn't in very good conformance with your view that the columbite should be divorced as much as possible from the lithium. I naturally agree with your general outlook but, recognizing that any production of columbite will be dependent upon lithium production, I am uncertain as to the degree to which they can be divorced. To get the production of columbium we ought to encourage mining, albeit primarily for lithium, of the ore richest in columbium.

As I understand the governmental procedure, the government's contribution to any exploration is repaid from a royalty on every material produced from a deposit on which a discovery has been certified, whether or not it is a strategic material. In the tin-spodumene belt the government could be reasonably sure of getting its money back if the royalties were definitely required on the spodumene, feldspar, and mica produced. If that were done, it would be in the government's interest to put enough emphasis on spodumene to permit a discovery to be certified even though no columbite were found. Any necessary lithium determinations might reasonably be charged against the project if that line is followed. If, as in the procedure outlined below, a couple of drill holes are used to prove downward continuation, I don't see how a couple of lithium determinations could be avoided.

As a basis for discussion, a procedure is outlined below for exploring the spodumene-bearing dikes. Be assured I'm not married to any of it, though I may argue in favor of it.

1. Examine the outcrops carefully and estimate the contents of spodumene and other minerals.

2. Evaluate the possibility of mining rock of that composition if the reserves were adequate.

3. If the spodumene content is at least marginal, prove by diamond drilling that the reserves are enough to justify the expense of further exploration. This probably would require about 600 ft of hole at a cost of about $3600. If the spddumene content is found on the outcrop to be substantially below the minimum required for mining and no other readily recoverable mineral is found in substantial amounts, the drilling, and all other work, might be avoided.

4. If the reserves proved by drilling are small; that is, if the dike does not persist to 200 ft depth, or some better figure, discontinue exploration.

5. If the dike is found to continue to a satisfactory depth and the spodumene content remains adequate, open a series of trenches across the dike. I would suspect, just to pull a figure out of the air, that the cross sectional areas of the trenches probably ought not be less than 4 square feet. This means that a ton of sample would be obtained from each $2\frac{1}{2}$ to 3 ft. of trench length. Because of the spotty distribution of columbite the trenches might have to be only 10 or 15 ft apart. The kaolinized rock might best be taken by volume rather than by weight so that the grade of the fresh rock might be computed or the fresh weight be determined by assuming some particular reduction in density during weathering.

6. The samples or splits thereof should be crushed and the heavy minerals separated. This is suggested instead of assaying as the low Cb content probably would mean a rather high percentage error in the assays and a good recovery of the heavy minerals should be easy to obtain. This will require the treatment of so large an amount of rock that the building of a small mill might be justifiable. Foote probably could handle their samples in their laboratory at the Kings Mountain mill but no other potential applicant is so favorably fixed.

The first four steps are in large part evaluation of the spodumene potentialities of the deposits, although provision could readily be made for the study of other minerals. It is possible that small grab samples might be taken, crushed, and panned during the first stage, but I don't know just what would be accomplished by doing so. I suppose that the complete absence of columbite from all grab samples from a dike might be justification for quitting. Do you think that many small samples taken on, say, a 1 or 2 ft. grid would give a reliable indication of the columbium content? If so, such sampling could be substituted for step 5 and for part, perhaps a quarter, of the samples taken in the first step, and no further work would be undertaken unless at least a small columbite content were found. Some such procedure would be more flexible than trenching, and in the early steps it would relieve the obvious emphasis on spodumene.

If in any dike it looked as though sampling and assaying would cost less than the diamond drilling, it could be done first and the drilling not undertaken unless the grade is proved to be satisfactory. The cheapest check on the possible value of the dike could thus be made first, followed if necessary by the more expensive.

Naturally, the question that remains largest is that of the advisability of undertaking any exploration with government funds.

Sincerely yours

/s/ Wally

Wallace R. Griffitts

3/12/53 gla

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

March 11, 1953

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
MAR 12 1953

Mr. F. Sommer Schmidt,
Defense Minerals Economic Admin.,
Room 4640,
New Interior Building,
Washington, D. C.

Re: Docket DMEA-2841

Dear Mr. Schmidt:

Would you be so good as to remove the property map from the exploration proposals sent you and substitute the attached maps? These are more accurate in representing the position of channeling and drill holes in the pegmatites.

Very truly yours,

FOOTE MINERAL COMPANY

L. G. Bliss
Vice President
In Charge of Sales

lgb:h

3/10/53

Fleischer
Ex 3627 Rm 1243
Schmitt

Foote Minerals Co DMEA 2841

Conference with Dr. Michael Fleischer concerning the applicability of using spectographic method in determination of the heavies in drilling the spoodumene b belt. Dr. Fleischer is the authority in the U.S. G.S. and author of Geological Survey circular 225 on spectrographic analysis.

He gave the sensitiveness as follows;

Columbium	.01%
Tantalum	.10 or .08%
~~Be~~ Beryllium	.0001 %
Tin	.001 %

~~the ideal range is anything under 1%~~

It does not matter whether these elements are combined, or as metals, The percentage given above is for the metal in whqtever form it may be.

He emphasised that in minute quantities the wet method would not be as accurate.

If the percentage ran over 1% then the wet method is more applicable.

~~This means that if a concentration of the drill cores and sludge is made, that the above elements can be readily determined.~~

3/12/53

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

March 10, 1953

Mr. F. Sommer Schmidt,
Defense Minerals Economic Admin.,
Room 4640,
New Interior Building,
Washington, D. C.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
MAR 12 1953

Dear Mr. Schmidt:

We sincerely regret the inconvenience we have caused you by our mathematical errors in our compilations dated March 6, 1953.

The source of error is obvious. The dollar value per pound was multiplied by the total heavies rather than the content of the heavies. Please substitute the attached sheet which we believe to be accurate.

We advise that our current recoveries of heavies from the head feed are approximately 50% based on the use of 8 spirals. We are installing 32 spirals which should improve recoveries materially. The actual extent of improvement should be known within the next six months.

Very truly yours,

FOOTE MINERAL COMPANY

L. G. Bliss

L. G. Bliss
Vice President
In Charge of Sales

lgb:h

The following figures are the actual savings not the total content of the ore

Recd 3/13/52

We are currently operating at the rate of 120,000 tons head-feed per year. Based on this rate and an assumed value of $1.16 per pound for Tin, and $4.20 per pound for combined Cb_2O_5 and Ta_2O_5

	Pounds of heavies per ton of feed	Total lbs. of heavies	35% of heavies as Cassiterite	Tin lbs.	Value	25% of heavies as Columbite	Total lbs. of combined Cb_2O_5, Ta_2O_5	Value
Peg 25	.45	54,000 lbs.	18,840 lb.	11,300	$13,110	13,500 lbs.	9,450	$39,700
Peg 8	.12	14,400 lbs.	5,040 lb.	3.024	3,530	3,600 lbs.	2,520	10,580
At rate of 360,000 tons per year								
Peg 25	.45	162,000 lbs.	56,520 lb.	33,900	$39,300	40,500 lbs.	28,350	$119,000
Peg 8	.12	43,200 lbs.	15,120 lb.	9,072	10,520	10,800 lbs.	7,560	31,750

Based on our current rate of 120,000 tons of head-feed per year

	Pounds of Beryl per ton of head-feed	Pounds of BeO per ton head-feed	Total Pounds of Beryl	BeO	Total Values, assuming $45.00 per unit of BeO
Beryllium Oxide					
Peg 25	Not Known	Not Known	Not Known		Not Known
Peg 8	7.5	.75	900,000 lbs.	90,000#	$202,500
Anticipated Rate of Production 360,000 tons of head-feed per year					
Peg 8	7.5	.75	2,700,000 lbs.	270,000	$607,500

Shipments to date -

1/21/53	3,680 lbs.	columbite at 62.6% conc.	$9,120.00
10/13/52	5,085 lbs.	columbite at 73.6% conc.	16,161.54
	8,765 lbs.		$25,281.54
11/4/52	16,250 lbs.	cassiterite at 60.67% conc.	$10,680.49

We are currently operating at the rate of 120,000 tons head-feed per year. Based on this rate and an assumed value of $1.16 per pound for Tin, and $4.20 per pound for combined Cb_2O_5 and Ta_2O_5

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At rate of 360,000 tons per year								
Peg 25	.45	162,000 lbs.	56,520 lb.	33,900	$39,300	40,500 lbs.	28,350	$119,000
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Based on our current rate of 120,000 tons of head-feed per year

	Pounds of Beryl per ton of head-feed	Pounds of BeO per ton head-feed	Total Pounds of Beryl	Total Values, assuming $45.00 per unit of BeO
Beryllium Oxide				
Peg 25	Not Known	Not Known	Not Known	Not Known
Peg 8	7.5	.75	900,000 lbs.	$202,500
Anticipated Rate of Production 360,000 tons of head-feed per year				
Peg 8	7.5	.75	2,700,000 lbs.	$607,500

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3/10/53 gla

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

March 6, 1953

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
MAR 9 1953

Mr. F. Sommer Schmidt
Defense Minerals Economic Administration
Room 4640 New Interior Building
Washington, D.C.

Dear Mr. Schmidt:

We attach hereto a property map which indicates the boundries of our property and the location of the drill holes, channels and pegmatites incidental to our proposal known as - DMEA 2841 - Exploration Assistance Williams Property - Tracts 1,2,3,4.

We also attach a resume of Cassiderite, Columbite recovered from pegmatites 18, 21, 25, and 8, as per my agreement with you on March 4, 1953.

Again I wish to state that the time spent with you was as pleasant as I have had. I hope to have the opportunity of hearing more about your so-called hobby at a future date.

Very truly yours,

FOOTE MINERAL COMPANY

L. G. Bliss
Vice President in Charge of Sales

lgb:mbw

P. S. The map will be forwarded, under separate cover in a few days.

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

March 6, 1953

Mr. F. Sommer Schmidt
Defense Minerals Economic Administration
Room 4640 New Interior Building
Washington, D.C.

Dear Mr. Schmidt:

The general composition of the rock that we are mining is as follows:

15 - 20%	Spodumene, basis 6% Li_2O, value $15.00 per unit of Li_2O
Approximately .03%	Columbite
.03 - .05%	Cassiterite
3%	Mica
45%	Feldspar
.4%	Beryl
30 - 40%	Quartz

We call your particular attention to the fact that Beryl as reported by you at .04% is really BeO; whereas, a more accurate figure for Beryl would be .4%.

Very truly yours,

FOOTE MINERAL COMPANY

L. G. Bliss
Vice President in Charge of Sales

lgb:mbw

Custer, S. Dak.
March 5, 1953

Foote
2841

W. R. Griffitts
Denver Federal Center
Denver, Colo.

Dear Wally:

Gordon Chambers button-holed me during the AIME meetings in Los Angeles in order to discuss the Foote Mineral applications at Kings Mountain.

He told me that their production of columbite-tin concentrates has ranged from a high of 6,000 pounds to a low of 600 pounds from 10,000 tons of rock. The cause of this difference may be due partly to milling, but presumably the principal factor is an actual change in grade of the deposit. The difference between these two figures is darn well significant with regard to domestic columbite supply, and inasmuch as it amounts to about two dollars per ton of rock, it is also significant with regard to the economics of the mining operation.

Thorough documentation supporting these figures would be very strong evidence in presenting the Foote side of the case to DMEA. It might well mean that Government participation will be justified in determining the columbite content of the deposits, so that the company will be more likely to mine rock that is relatively rich in columbite. I suggested to Chambers that he submit such documentation to DMEA. By this, of course, I meant a really complete report containing all the facts demonstrable from past operations, not just the usual unsupported statements that the columbite content has varied.

In talking with Chambers, I as much as told him that I didn't see how his most recent application could be accepted in the form in which I last saw it. I implied that more complete evidence regarding columbite variability might change the opinions of various people, but that was as far as I went. If DMEA should ultimately decide to make a contract on this project, I think that the columbite should be divorced as much as possible from the lithium. Certainly, for example, the costs of lithium analyses should not be shared by the Government, probably other costs should also be assigned to lithium, and thus paid entirely by the company, rather than partly by the Government.

Any opinions that you have on this will be welcome. I'll be back in Washington on March 9, so write me there.

You'll be interested to know that Dave Larrabee is taking my job in Washington.

Norton has never been on this property
Sch

Sincerely,

James J. Norton

Lith carb. Lepidax 90¢ lb.

Spod. $10-$14/unit of Li_2O

Duluth Sod Thes. $175/ton.

Lith metal 98% $9.85 to 11.00/lb.

	Lithium Ore Tons	$	Li_2O
1949 -	4838	345,970	475
50 -	9306	579922	747
51 -	12000		9.00
52 -	20,000		

Glass & ceramics
Lubricants
Air conditioning
Storage Batteries Wet & dry
welding

2/25/53gla

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

February 23, 1953

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
FEB 24 1953

Mr. F. Sommer Schmidt,
Defense Minerals Economic Administration,
Room 4640 New Interior Bldg.,
Washington, D. C.

Dear Mr. Schmidt:

RE: DMEA-2841 - Exploration Assistance
Williams Property - Tracts 1,2,3,4

Tony Bliss has requested that I write you relative to our interests and recommendations regarding exploration of Williams Tracts 1, 2, 3, and 4.

Although it is well recognized in mining circles that certain types of pegmatites are not too dependable in reference to uniformity throughout the ore body, we can speak from several years of experience in the Kings Mountain area.

1 - To date we have opened and quarried four pegmatites known as pegmatites 18, 21, 25 and 8. These ore bodies have been proven to consist of both weathered and unweathered rock. We have further found that trace minerals such as Cassiterite, Columbite and Beryl have been fairly uniformly distributed throughout any given pegmatite. For example, pegmatite 25 was essentially a hard unweathered rock formation and it has been proven to contain the highest percentage of Columbite and Cassiterite we have experienced among the four pegmatites worked. Pegmatites 18 and 21 were mixtures of weathered and unweathered rock depending upon the depth to which they were worked, and from experience, which has correlated with the core drillings originally made, the Columbite, Cassiterite and Beryl are fairly uniformly distributed between the weathered and unweathered rock.

Pegmatite 8 - At this time we have two benches on pegmatite 8. We have drilled to a depth of 150'. The core drillings indicate that the Columbite and Cassiterite are not as abundant in pegmatite 8 as was the case in 25, 18 and 21. Subsequent production experienced from the mining and beneficiation of rock obtained from pegmatite 8 substantiated the findings of the core drilling.

2 - As far as we know, there is no good chemical analysis researched and reported at this time which would permit a quantitative determination of Columbite and Cassiterite in the rock. To circumvent this difficulty we are researching a procedure which is very close to fruition which is as follows:

A - The rock is crushed and subjected to a super-panner means of separating the gangue from the heavies. It is our belief that this method of separation is the best quantitative approach to the problem currently known.

B - The heavies in the concentrated form can then be analyzed by well known chemical methods of procedure and a quantitative assay of Columbite and Tin in the Cassiterite can be effected.

C - From the above two approaches to the problem it is evident that a fairly good quantitative result can be obtained.

3 - Despite generally conceived notions as to the independability of pegmatites the fact remains that many pegmatites are being worked profitably and commercially. The Government of the United States, many years ago, defined within broad limits the existence of Columbite, Cassiterite, Beryl and Spodumene in the belt under consideration. The methods used in defining these ore bodies consisted of core drilling, trenching and channeling. On the basis of that work comprehensive reports have been published. It appears logical to us that similar methods applied within more limited areas of the richer ore bodies so reported by the Government should develop specific pegmatites which give indications of richer contents of Columbite, Cassiterite, and Beryl, so important to the partial mobilization program of our country today. We say this not as prospectors but as a company which is currently operating sizable flotation units which are dependent upon rock mined in the immediate area. The experience obtained in the production of commercial quantities of Cassiterite and Columbite can do little but lead us to the conclusion that there is at least a qualitative correlation between the results obtained in core drilling and channeling and commercial production. To date we have produced and sold to the U. S. Government approximately 26,000 lbs. of heavy minerals in the form of cleaned Columbite and Cassiterite.

4 - It is our earnest belief that it would not only be to the advantage of the Foote Mineral Company, but also to the U. S. Government, if our operations were confined to those pegmatites showing highest percentages of Columbite, Cassiterite and Beryl. It is evident that the Government desires these minerals, since the only market for the Cassiterite of any magnitude is with the Government, and since the Government currently is encouraging the production of Columbite through the payment of a bonus. The importance of Beryl is well known to the Atomic Energy Commission.

Mr. F. Sommer Schmidt,
Defense Minerals Economic Administration

February 23, 1953

5 - We quickly admit that we have not as yet evolved the proper metallurgical approach to permit separation of Beryl from the rock in commercial quantities. However, not only our laboratories, but Government laboratories in cooperation with us, are working on this problem and at this time we have made encouraging progress. Should a process be developed in the near future for the recovery of Beryl it seems tantamount to good logic that the quarrying operations to obtain the rock for the mill feed be at a location where the largest percentage of Beryl and other strategic minerals are found.

6 - The Foote Mineral Company has already expended several million dollars for a chemical plant to provide Lithium chemicals, at Sunbright, Virginia, which will operate on Spodumene produced in Kings Mountain area. To feed this plant will require increasing quantities of Spodumene. We now know that pegmatite 8 will support the Sunbright operation, as far as Spodumene is concerned, for many years to come. We further know that pegmatite 8 is lowest in Tin, Columbite and Beryl contents of any of those pegmatites we have examined to date. We intend to spend additional money to increase the capacity of the Kings Mountain mining operations. We therefore believe it equitable that the Government assist us in defining those ore bodies which would permit the greater recovery of the strategic minerals through the granting of this relatively small exploration contract.

7 - We attach herewith the property map showing the approximate locations of the pegmatites we are proposing to explore. These pegmatites are more definitively shown in a map already in your possession which is a photostat of the geological survey. We also attach a map showing the pegmatites numbered as we know them.

8 - Experience has shown that the average holes in one body have correlated well with results of actual mining. We are proposing channeling of an estimated footage of 2140'. It is our belief that we will be able to show strong indications of pegmatites of interest for future workings with this much channeling, if those channelings are supported with the core drilling proposed.

Very truly yours,

FOOTE MINERAL COMPANY

F.B. Shay

F. B. Shay
Vice President - Production

fbs:b:h

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

February 20, 1953

Mr. F. Sommer Schmidt,
Defense Minerals Economic Admin.,
Room 4640,
New Interior Bldg.,
Washington, D. C.

Dear Mr. Schmidt:

You may recall when I had the pleasure of visiting with you in Washington that you indicated an interest in Geomines, which is an open pit Tin producer in the Belgian Congo.

I had mentioned at that time that the ores they worked were essentially similar to those we are quarrying at Kings Mountain which are actually pegmatites.

I also stated that they apparently were making a profit out of the recovery of very low-grade Cassiterite and Columbite.

You wanted a reference to these articles, which is as follows:

Geomines--A Major Open-Pit Tin Producer in the Belgian Congo - Engineering & Mining Journal Vol. 153, No. 11.

How Geomines will Treat 24,000 Tons of "Hard" Tin Ore per Day -- Mining World - World Mining Section, November 1952.

Very truly yours,

FOOTE MINERAL COMPANY

Tony Bliss

L. G. Bliss
Vice President
In Charge of Sales

lgb:h

2/17

Copie from Bliss Philadelphia Victor 4/9/14
Gone to Bliss

The question has been raised whether these dikes can be sampled by drilling

It is thought that like all pegmatite dikes that the mineralization occurs in zones and not disseminated throut the dike. and that the spodumene might be fairly well distrubuted that the columbium and tantalum ma y be bunchy.

Have you any data that shows sampling or values of the columbiuk and tin as being evenly distributed throughout the dike.

Would drilling give us enough material for sampling these low grade values.

I asked Bliss to get one of his geologists or engineers to explain their position on the above questions and he said he would.

2/17 Wait for the above report from Foote

1/28/53 gla

IN REPLY REFER TO:

G-MD-CNM

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JAN 27 1953

January 26, 1953

Memorandum

REVIEW OF APPLICATION DMEA-2841 (columbite, tantalite, tin, beryl)

To: E. W. Ellis, Defense Minerals Exploration Administration
From: J. J. Norton, U. S. Geological Survey
Applicant: Foote Mineral Company.
Name of property: Williams Property.
Location of property: Cleveland County, North Carolina.
Estimated cost of project: $26,841.
Summary of applicant's proposal:

1) Drill 2,100 feet of diamond drill holes, and split, log, and analyze cores for Be, Cb-Ta, Sn.
2) 2,140 feet of channelling.

Sources of information pertinent to this application:

1) Kesler, T. L., 1942, The tin-spodumene belt of the Carolinas: Strategic minerals investigations report, U. S. Geol. Surv. Bull. 936-J.
2) Docket DMEA-2547.

Comments:

The property covered by this application is in the same area as the property covered by DMEA-2547, and the problems concerning these two applications are essentially the same. Inasmuch as the final decision on DMEA-2547 was to deny the application, I think that this application also has to be denied.

The only fact that could possibly be cited to show that this application differs from the earlier one is that no data have been acquired on the characteristics of the deposits on this property at depth. Nevertheless, the applicant seems quite certain that large reserves of spodumene pegmatite~~s~~ are available, and all that must be done is to delineate the reserves by means of what I would call development drilling and channel sampling. The chief purpose of the proposed work would be to outline spodumene reserves. Tin, tantalum, and columbium would be by-products that would depend on spodumene production, just as in DMEA-2547. The beryl cannot be profitably recovered by any method now known.

RECOMMENDATION:

Denial.

J. J. Norton

J. J. Norton

1/22/53 gla

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

Gone Victor 49214

January 20, 1953

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JAN 21 1953

Mr. Ernest W. Ellis, Chief,
Rare & Miscellaneous Metals Division,
Defense Minerals Exploration Administration,
New Interior Bldg.,
Washington, 25, D. C.

RE: Docket No. DMEA-2841

Dear Mr. Ellis:

On January 8, 1953, we submitted an exploration proposal which has been identified by your office as DMEA-2841.

At the time of submitting this proposal we did not have "Owner's Consent to Lien" executed. That has now been done and we attach herewith four copies. We hope that you will see that these are included with our proposal and that we may shortly have the opportunity of executing a contract along the lines proposed.

Very truly yours,

FOOTE MINERAL COMPANY

L. G. Bliss

L. G. Bliss
Vice President

lgb:h

cc: Mr. L. Houck

1/15/53 gla

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON 25, D. C.

January 13, 1953

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JAN 14 1953

Memorandum

To: L. G. Houck, Chief
Nonmetallics Division, DMEA

From: Robert F. Griffith
Rare and Precious Metals Branch

Re: Columbite-Tantalite,
Tin, and Beryl

Subject: Docket DMEA-2841, Foote Mineral Co., 18 W. Chelten Ave., Philadelphia 44, Pa. Williams Property, Cleveland Co., Kings Mt., N. C.

In reviewing the subject application, the following items should be considered:

The potential production of columbite-tantalite from the spodumene belt, near Kings Mountain, N. C., is twelve times greater than the entire domestic production in 1951. No analysis is given of the 20 tons of columbite reportedly produced by Foote Minerals (Noted on page 2 of subject docket) at their Kings Mountain plant since September, 1951. However, a communication from B. H. Clemmons, Chief, Metallurgical Branch, Region VII, checks this tonnage fairly well. This communication states that in December, 1951, the Company reported a 2700 lb. per month production of mixed-concentrates assaying 35-45 percent tin* and 20-30 percent columbite. Tantalite was low. In December, 1952, the Company reported a 1/2 - 3/4 ton per month production. On the latter date, mining was being conducted on a different pegmatite which appeared to contain a lower tin-columbite content. The subject property is reported as being favorable for a higher tin-columbite-beryl content. The company's new mill will treat from 5 to 6 times the quantity of ore now being beneficiated. The recovery of tin-columbite is believed to be low--40 to 50 percent. A Bureau of Mines project to improve the recovery of these minerals has been approved recently.

* Is this tin or cassiterite.

A cooperative agreement has been made between the Bureau and Foote Minerals for joint beneficiation studies to recover the beryl from the Kings Mountain spodumene deposit.

The necessity for the $2300 item for a consulting geologist is questioned. The holes have been located and it is believed that Mining Engineers Shay and Rainy are familiar enough with the geology of the spodumene belt to cope with any geological problems.

It is noted that a total of $6000 is requested for analyses of samples. It is assumed that Foote Mineral will do this work and it is questioned if the Government should pay the 90 percent of this cost.

In view of the potential production of short-supply commodities from the subject property, this office recommends that the subject application be viewed favorably, subject to the above considerations.

Robert F. Griffith

Robert F. Griffith

RFGriffith:emt

1/13/53 jim

Manufacturers of Chemicals, Metals and Mineral Products

Foote MINERAL COMPANY

18 West Chelten Avenue Philadelphia 44, Pa.

CABLE ADDRESS "FOOTE PHILADELPHIA"

January 12, 1953

DMEA-2841

Mr. L. Houck,
U. S. Dept. of the Interior,
Defense Minerals Exploration Administration,
New Interior Building, Room 4639,
Washington 25, D. C.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JAN 16 1953

Dear Mr. Houck:

Thank you very much for a very pleasant visit with you on January 8th.

At that time I left with you four copies of our FORM MF-103, Application for Aid in an Exploration Project. It is our understanding that your first inspection of this proposal indicated that it was in order and that probably within 4 to 6 weeks we would receive a formal contract proposal authorizing the exploration.

In view of the fact that it might be possible to win important quantities of Columbite-Tin heavy concentrates and Beryl by judiciously selecting the proper pegs to quarry in the Kings Mountain area, we are very hopeful that you will be able to expedite this exploration of the four tracts named.

Should you find on closer inspection of our proposal errors of commission or omission, which should be rectified, we trust that you will inform us promptly.

Very truly yours,

FOOTE MINERAL COMPANY

L. G. Bliss
Vice President
In Charge of Sales

lgb:h

P.S. - I sincerely hope that you are able to get past the milk stage of that ulcer diet soon.

LGB

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

January 8, 1953

Mr. L. G. Bliss
Foote Mineral Company
18 W. Chelten Avenue
Philadelphia 44, Pa.

Subject: DMEA-2841
Re: Exploration Assistance
Williams Property - Tracts 1,2,3,4

My dear Mr. Bliss:

The receipt of your application dated December 30, 1952 for exploration assistance under the Defense Production Act of 1950, as amended, is hereby acknowledged.

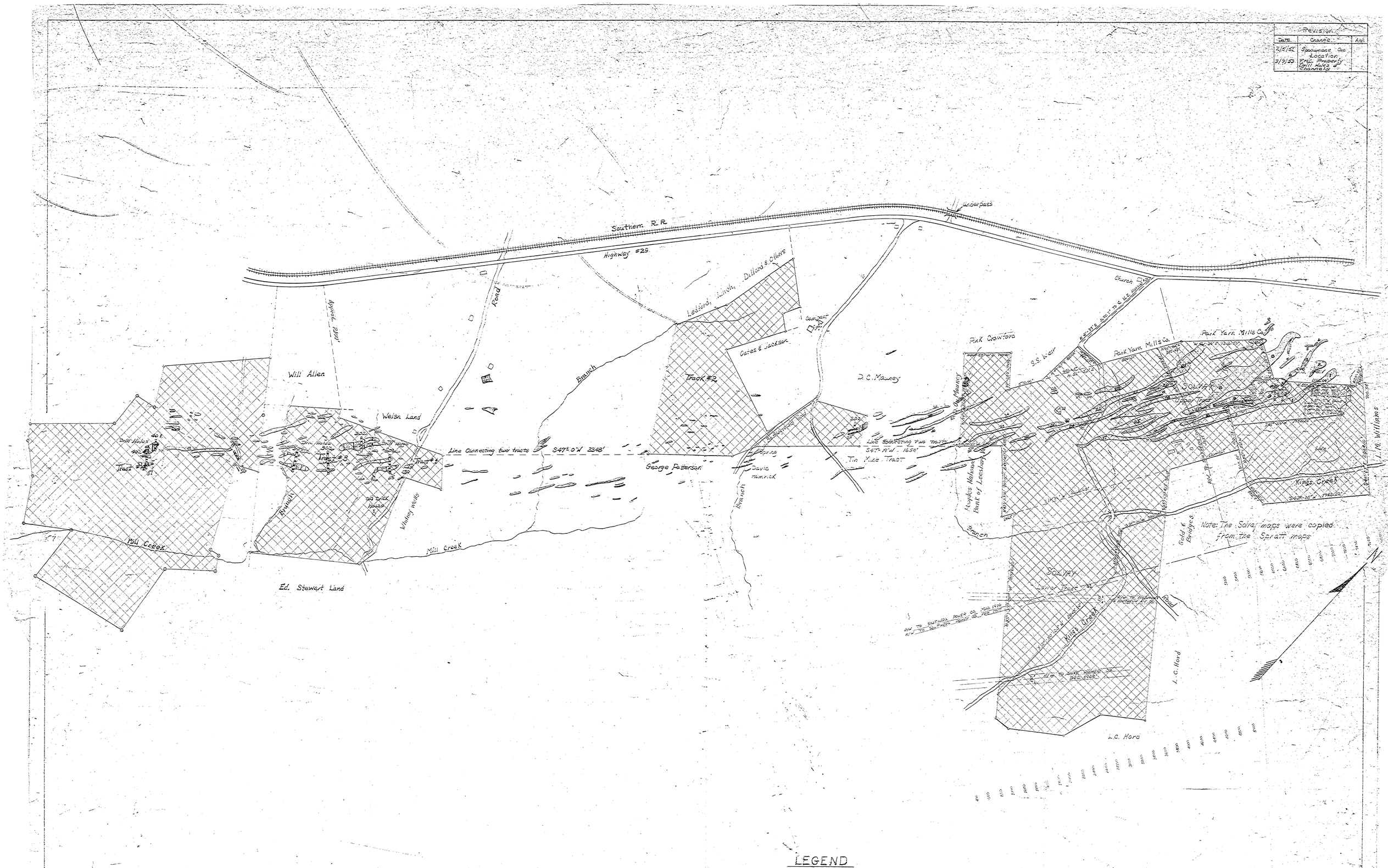
Your application has been assigned Docket Number DMEA-2841 and referred to the Rare and Miscellaneous Metals Division.

Kindly refer to DMEA-2841 in any future correspondence relating to your application.

Sincerely yours,

ROBERT E. ADAMS
Robert E. Adams, Chief
Operation's Control and
Statistics Division

Revision		
DATE	Change	Appr.
2/5/51	Spodumene Occ. Location	
3/9/53	Foote Property, Drill Holes & Channels	



LEGEND

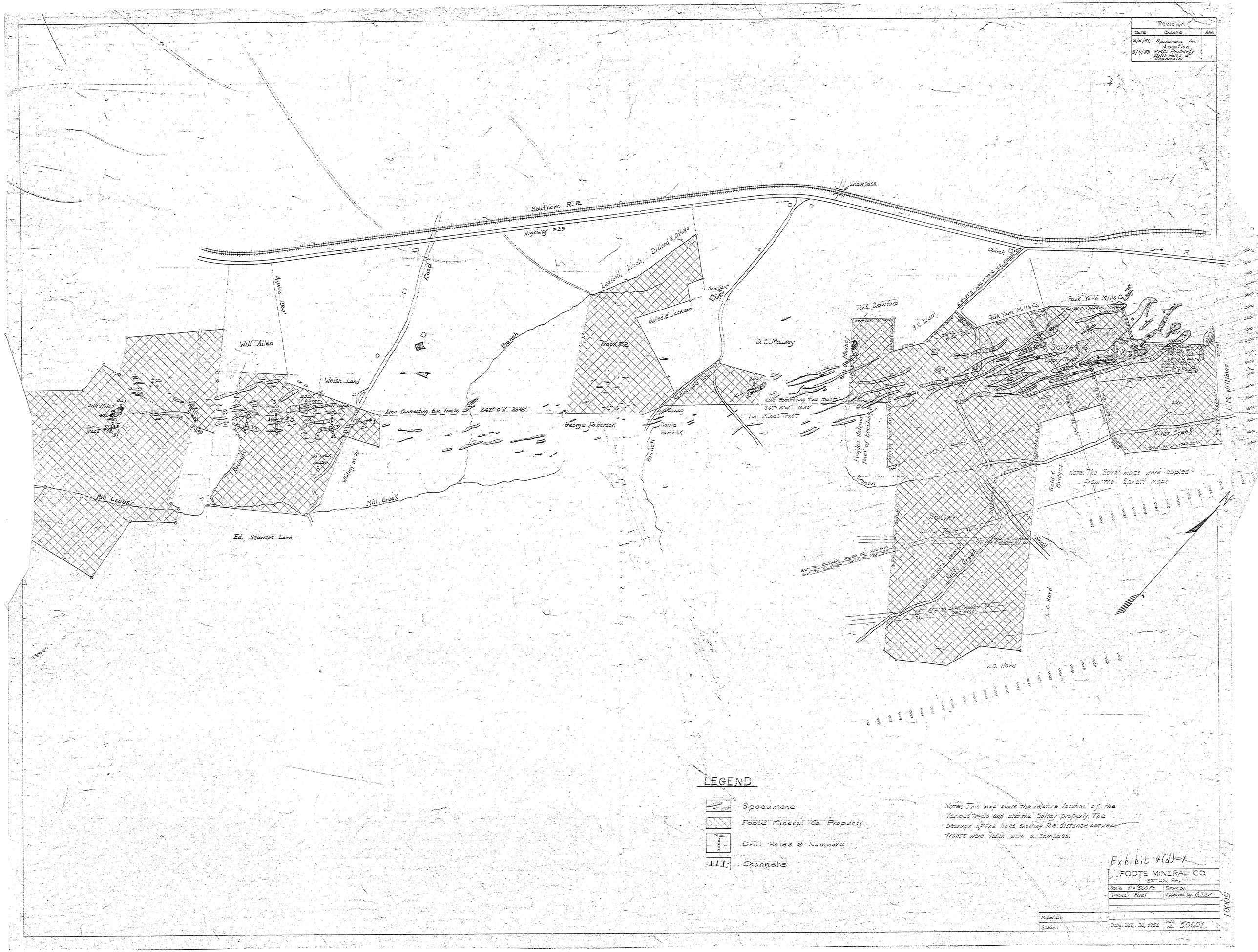
- Spodumene
- Foote Mineral Co. Property
- Drill Holes & Numbers
- Channels

Note: This map shows the relative location of the various tracts and also the Solway property. The bearings of the lines showing the distance between tracts were taken with a compass.

Exhibit A

FOOTE MINERAL CO. EXTON, PA.	
Scale 1" = 500 Ft.	Drawn by:
Traced: Friel	Approved by: C.P.S.
Material:	
Spec. No.	Date: Jan. 20, 1951
	DWG No. 50001

Revision		
Date	Change	Appr.
2/5/52	Spodumene Ore Location	
3/9/53	FMC Property Drill Holes Channels	



LEGEND

- Spodumene
- Foote Mineral Co. Property
- Drill Holes & Numbers
- Channels

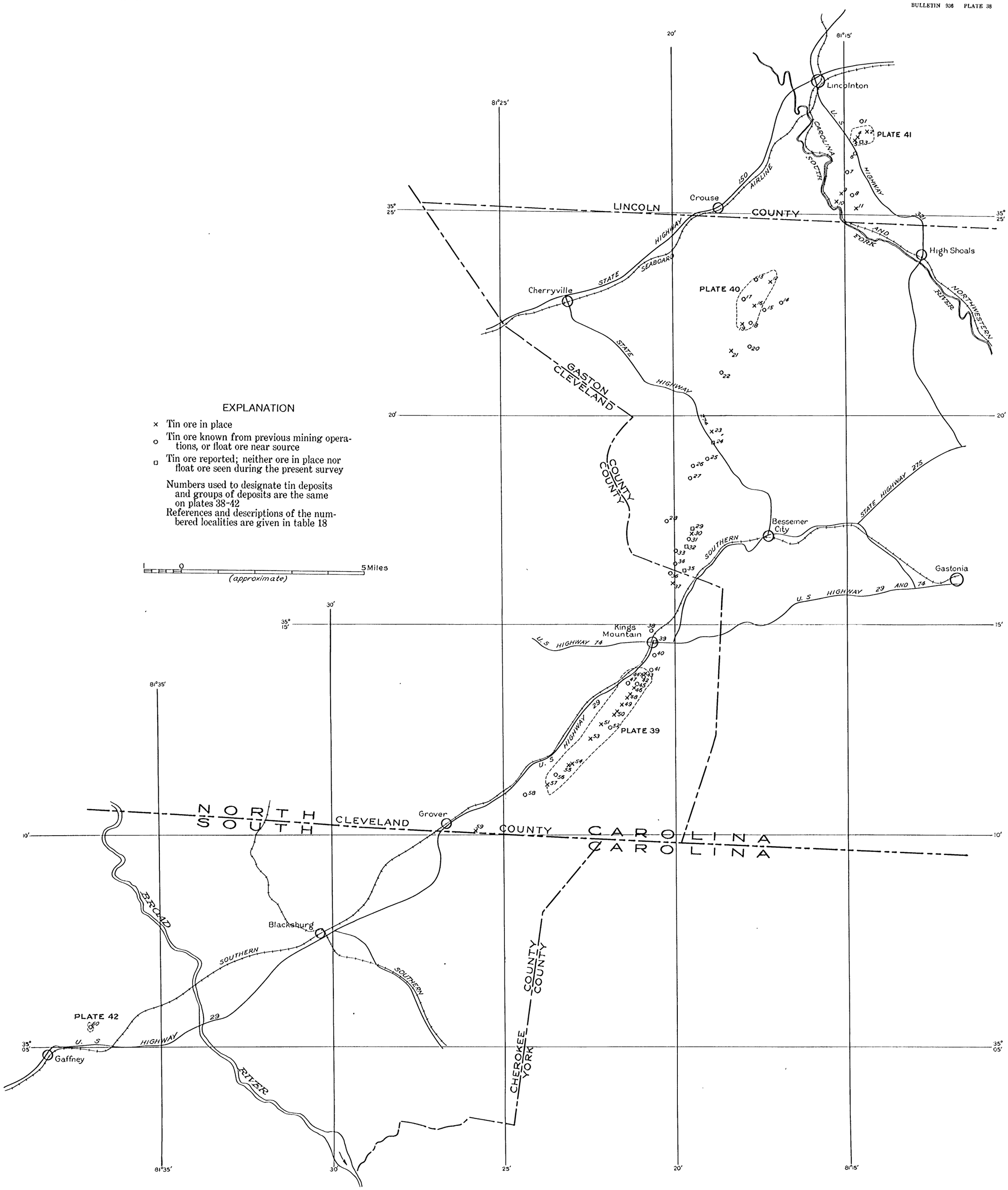
Note: This map shows the relative location of the various tracts and also the Solitaf property. The bearings of the lines showing the distance between tracts were taken with a compass.

Exhibit 4(d)-1

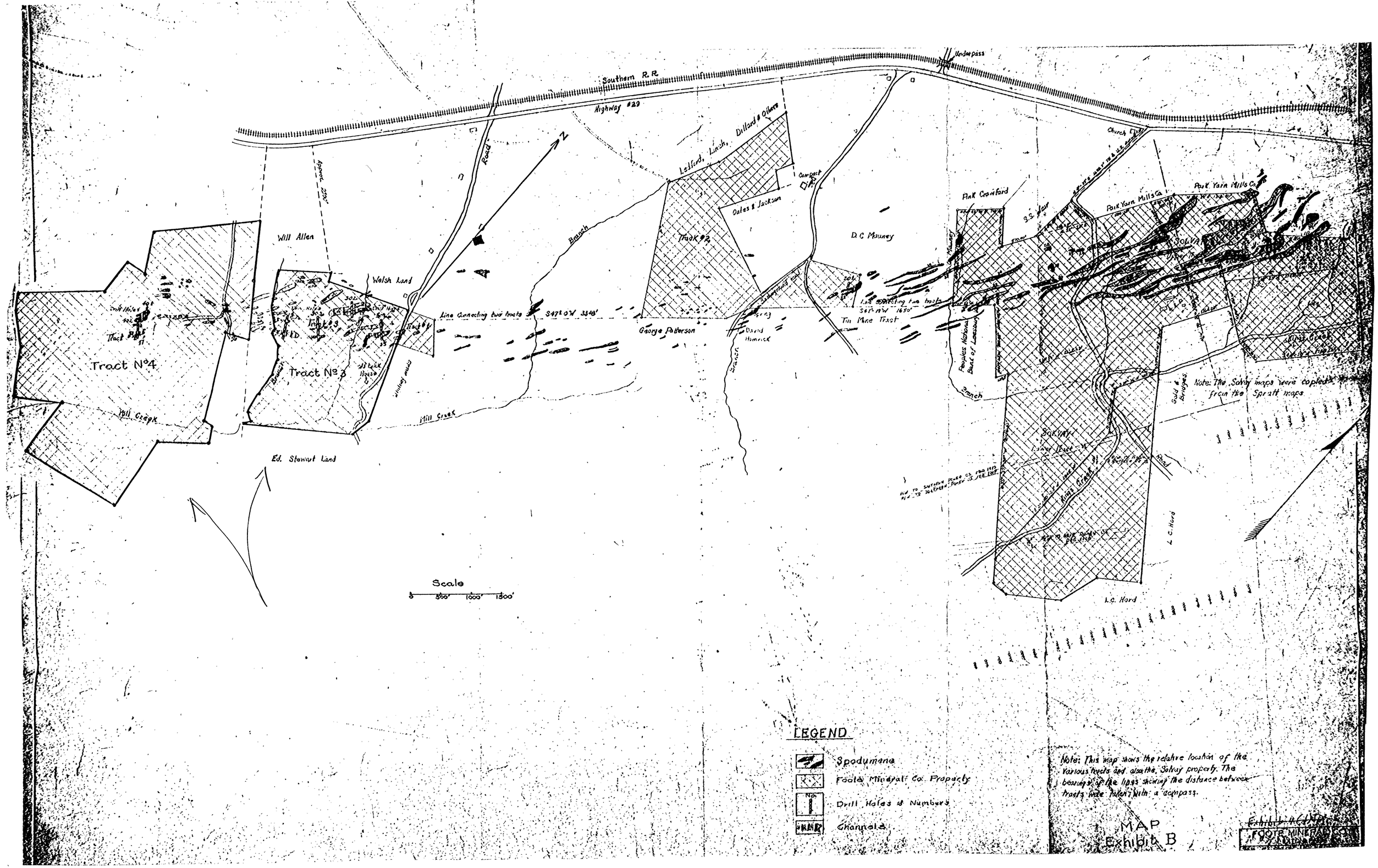
FOOTE MINERAL CO.
EXTON, PA.

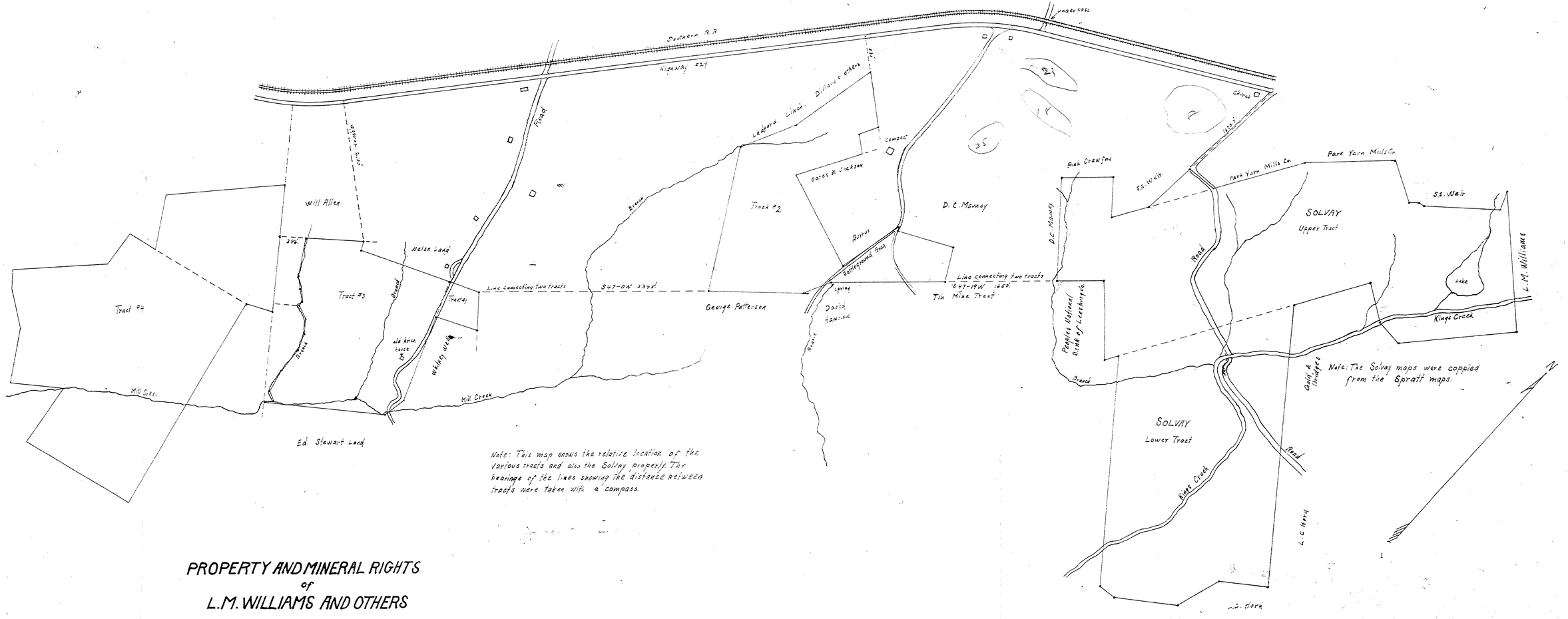
Scale 1" = 500 Ft.	Drawn by:
Traced: Final	Approved By:
Material:	
Specif.:	Date: Jan. 20, 1951 — Dwg. No. 50001

50001



OUTLINE MAP OF THE CAROLINA TIN-SPODUMENE BELT, SHOWING LOCATIONS OF TIN DEPOSITS AND PLATES 39-42


Southern R.R.
Highway #29
Underpass
Church
Road
Branch
Will Allen
Welsh Land
Tract No 4
Tract No 3
Tract #2
Tract #1
Mill Creek
Ed. Stewart Land
Line Connecting two tracts S 47° 0' W 3343'
Lelford, Linds, Dillard & Others
Oates & Jackson
Concrete
George Patterson
David Hamrick
D.C. Mauney
Tin Mine Tract
Line Connecting two tracts S 61° N W 1650'
Frank Crawford
Peoples National Bank of Lexington
S.S. Hall
Park Yarn Mills Co
SOLWAY
Gold & Bridges
Note: The Solway maps were copied from the Spratt maps
L.C. Hord
Scale
0 500' 1000' 1500'
LEGEND
Spodumene
Foote Mineral Co. Property
Drill Holes & Numbers
Channels
Note: This map shows the relative location of the various tracts and also the Solway property. The bearings of the lines showing the distance between tracts were taken with a compass.
MAP
Exhibit B
FOOTE MINERAL CO.

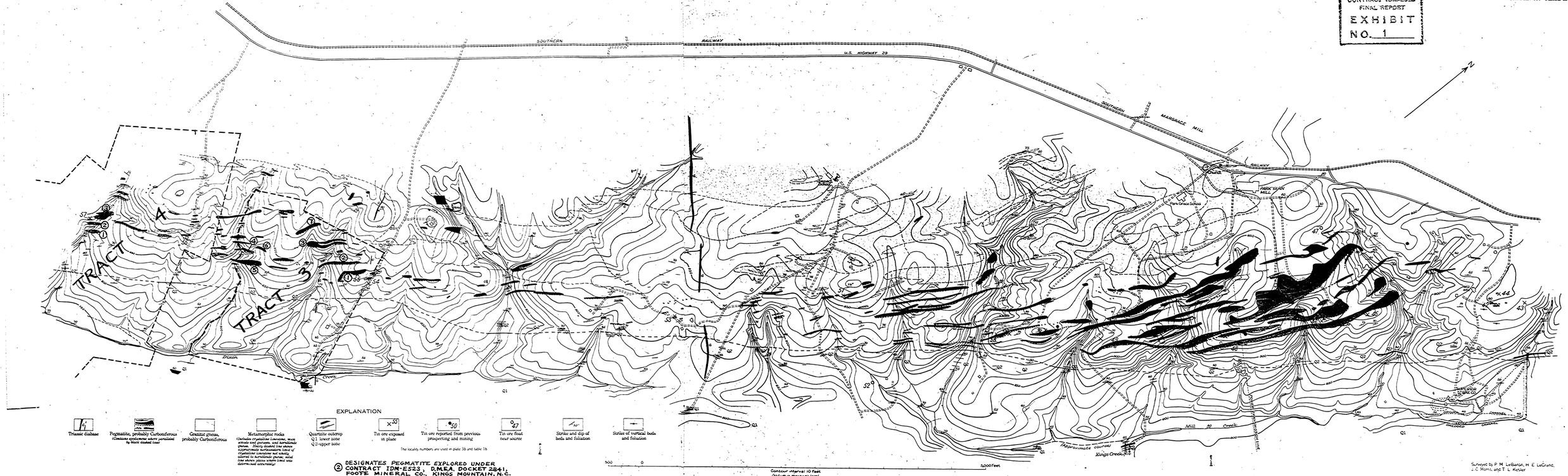


PROPERTY AND MINERAL RIGHTS
of
L.M. WILLIAMS AND OTHERS

surveyed & Mapped
by
L.B. Falls, Kings Mtn, N.C.
scale: 1in = 500 ft.
June 1949

Exhibit 4-d1

DMEA DOCKET 2841
CONTRACT IDM-ES23
FINAL REPORT
EXHIBIT
NO. 1



EXPLANATION

Triassic diabase

Pegmatite, probably Carboniferous
(Contains spodumene where persistent by black dashed lines)

Granitic gneiss, probably Carboniferous

Metamorphic rocks
(Includes crystalline limestone, mica schists and gneisses, and hornblende gneiss. Thinly dashed line shows approximate contact between Q1 of crystalline limestone and schists, colored to hornblende gneiss, dashed line shows places where (dip) was determined accurately)

Quartzite outcrop
Q1 lower zone
Q2 upper zone

Tin ore exposed in place

Tin ore reported from previous prospecting and mining

Tin ore float near source

Strike and dip of beds and foliation

Strike of vertical beds and foliation

The locality numbers are used in plate 3B and table 1b

② DESIGNATES PEGMATITE EXPLORED UNDER CONTRACT IDM-ES23, D.M.E.A. DOCKET 2841, FOOTE MINERAL CO., KINGS MOUNTAIN, N.C.

500 0 5000 Feet

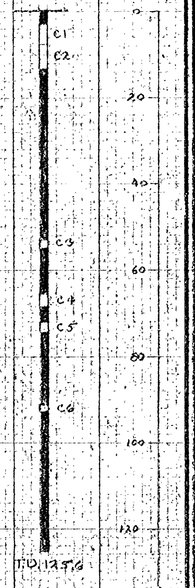
Contour interval 10 feet
Datum is mean sea level
1942

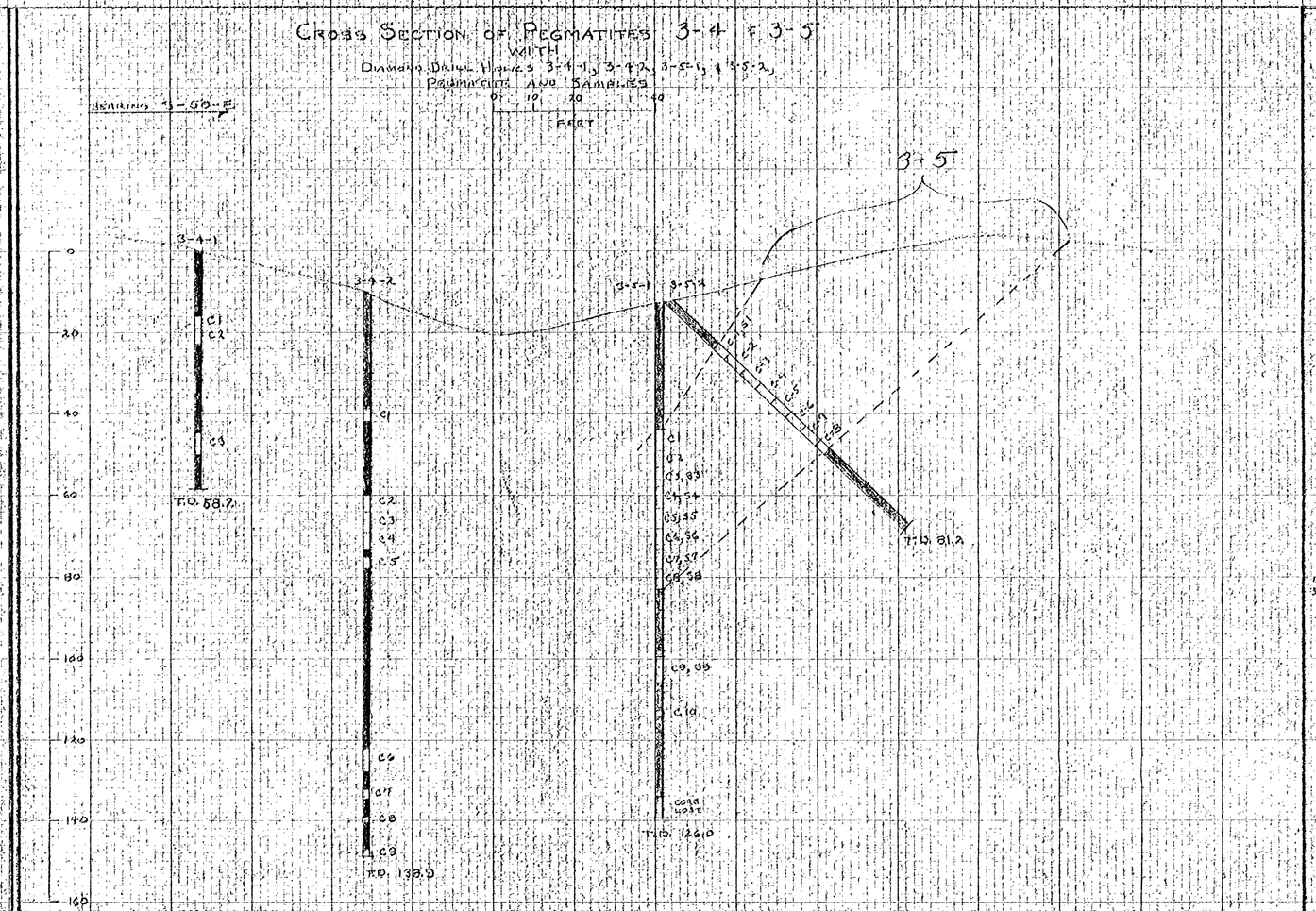
Surveyed by P. M. LeBaron, H. E. LeGrand, J. C. Morris, and T. L. Kesler

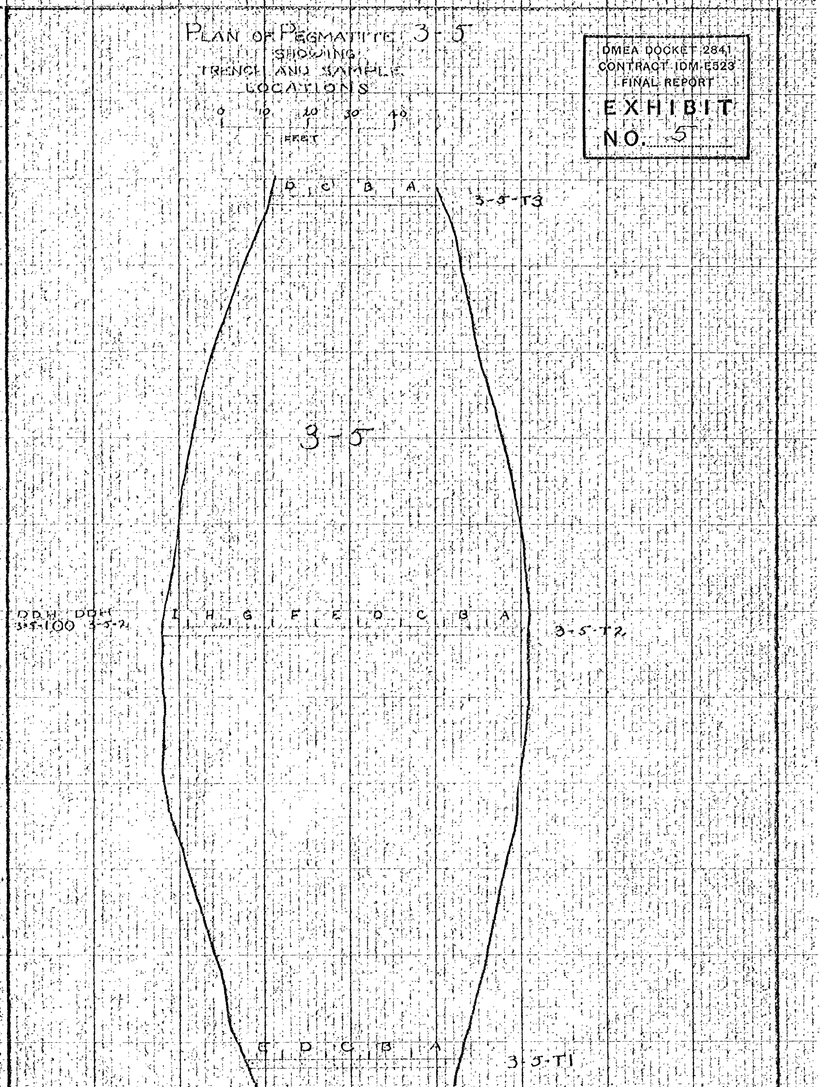
GEOLOGIC MAP OF PART OF THE TIN-SPODUMENE BELT SOUTHWEST OF KINGS MOUNTAIN, NORTH CAROLINA

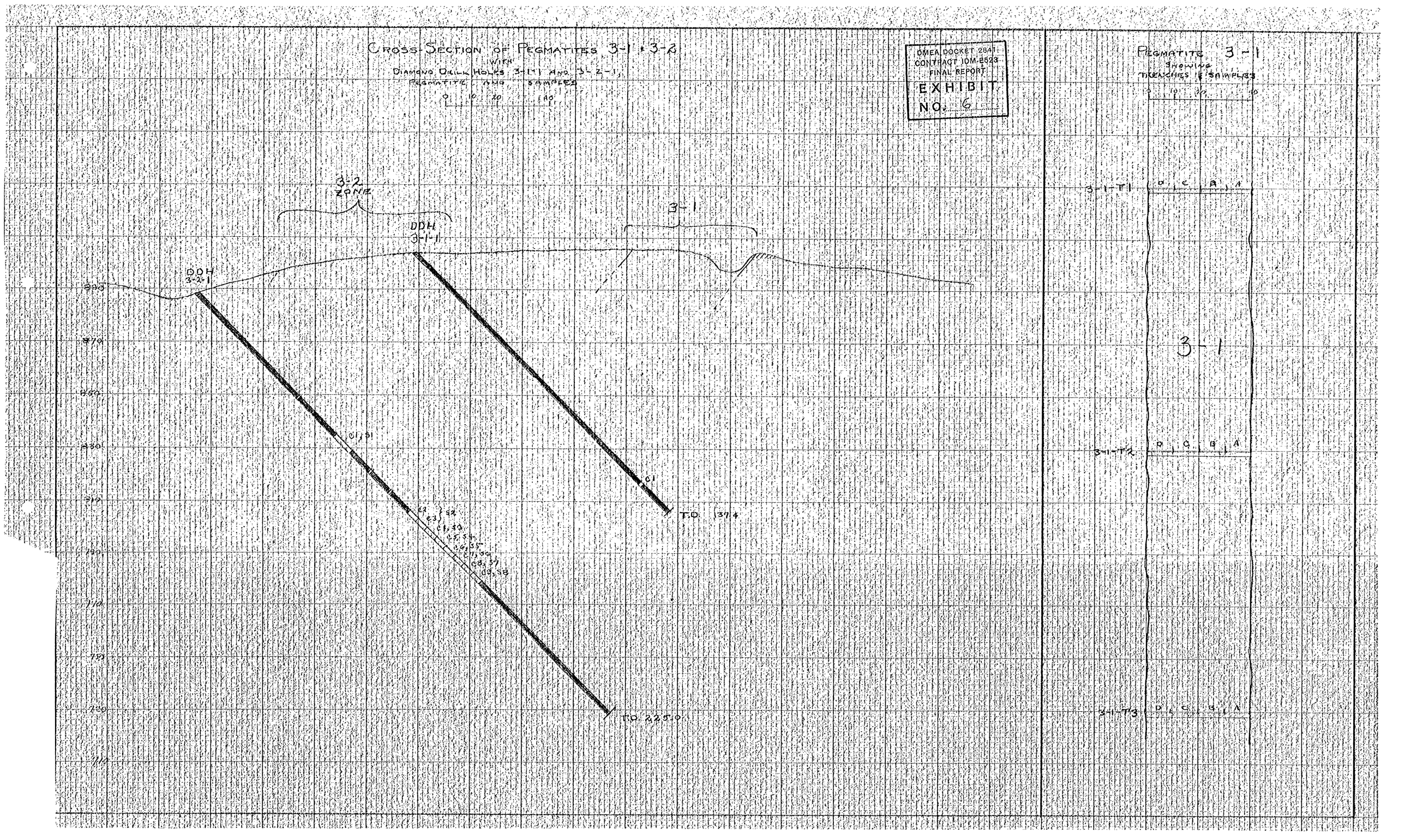
DMEA DOCKET 2841
CONTRACT IDM-E523
FINAL REPORT

EXHIBIT NO. 5








Cross-Section of Pegmatites 3-1 + 3-2
with
Diamond Drill Holes 3-1-1 and 3-2-1,
Pegmatite and Samples
0 10 20 40
DMEA DOCKET 2841
CONTRACT IDM-2523
FINAL REPORT
EXHIBIT
NO. 6
3-2
zone
3-1
DDH
3-1-1
DDH
3-2-1
890
870
850
830
810
790
770
750
730
C1, 51
C1
C2
C3, 52
C4, 53
C5, 54
C6, 55
C7, 56
C8, 57
C9, 58
T.D. 1374
T.D. 2250
Pegmatite 3-1
showing
trenches & samples
0 10 20 40
3-1-T1
D C B A
3-1
3-1-T2
D C B A
3-1-T3
D C B A

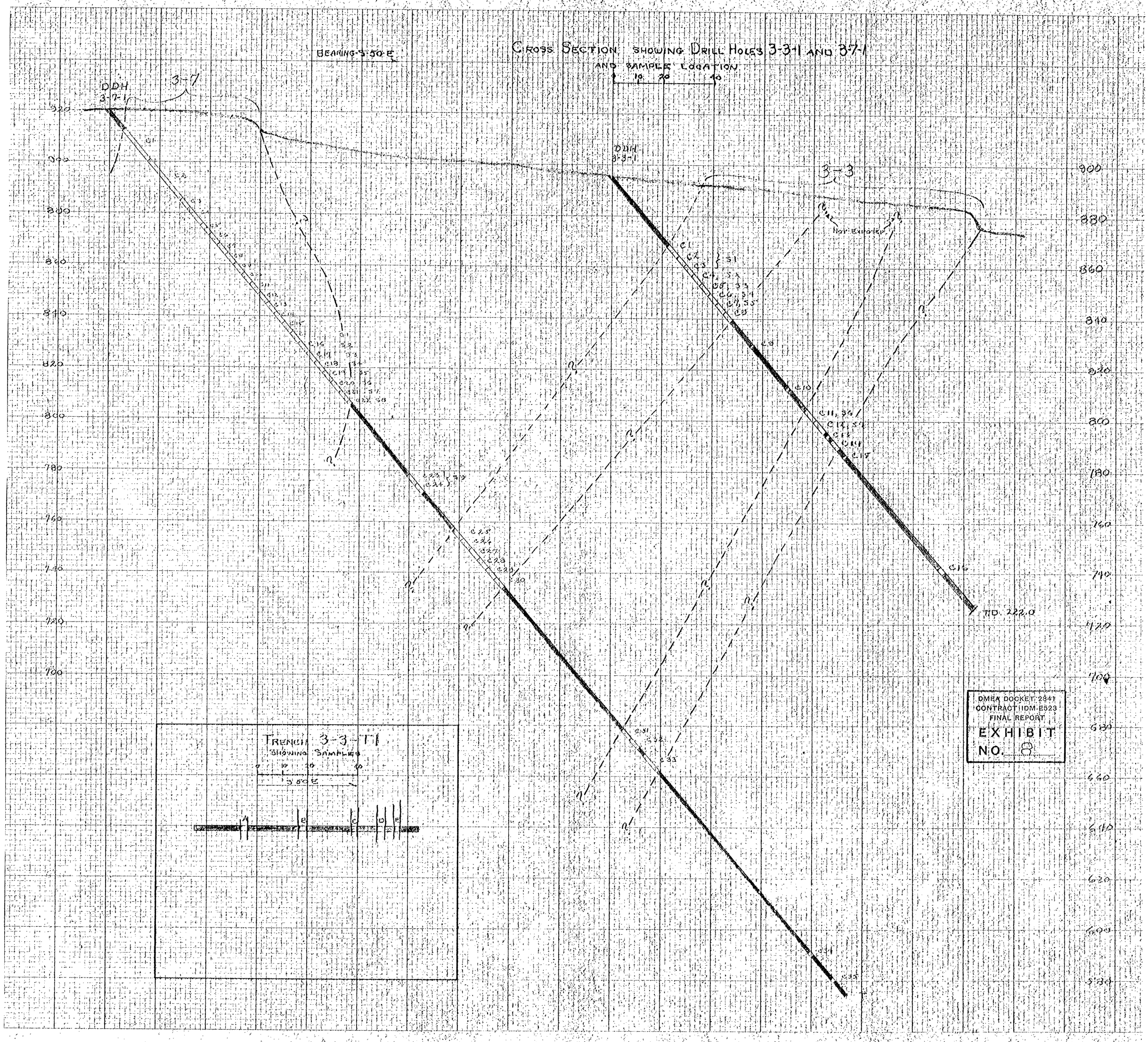

CROSS SECTION SHOWING DRILL HOLES 3-3-1 AND 3-7-1
AND SAMPLE LOCATION
0 10 20 40
BEARING S 50 E
DDH 3-7-1
3-7
DDH 3-3-1
3-3
Not Explored
TD. 222.0
TRENCH 3-3-T1
SHOWING SAMPLES
0 10 20 40
S 80 E
A
B
C
D
E
DMEA DOCKET 2841
CONTRACT IDM-E523
FINAL REPORT
EXHIBIT
NO. 8

TABLE OF ASSAYS

Pegmatite Number	Core Sample	Sludge Sample	Trench Sample	Li_2O	BeO	Sn	Cb_2O_5	Ta_2O_5
4-1	4-1-3-C1			0.49	<0.010	0.0011	0.0090	0.0024
	C2			NIL	<0.010	<0.0010	0.0072	0.0020
	C3			0.10	<0.010	0.0017	0.0570	0.0156
	C4			1.59	<0.010	0.0021	0.0044	0.0012
	C5			1.81	<0.010	0.0026	0.0072	0.0020
		4-1-3-S1		0.28	<0.010	<0.0010	0.0070	0.0019
4-3	4-3-1-C1			0.55	0.096	0.0040	0.0195	0.0048
	C2			0.36	0.071	0.0012	0.0155	0.0042
	C3			0.68	0.071	0.0036	0.0140	0.0038
	C4			0.93	0.058	0.0076	0.0165	0.0045
	C5			1.57	0.045	0.0047	0.0085	0.0022
	C6			0.38	0.040	0.0150	0.0140	0.0038
	C7			1.60	0.030	0.0090	0.0140	0.0050
	4-3-2-C1			1.17	0.038	0.0012	0.0036	0.0009
	C2			1.04	<0.010	0.0020	0.0072	0.0020
	C3			1.69	<0.010	0.0034	0.0180	0.0140
	C4			1.71	<0.010	0.0080	0.0062	0.0017
		4-3-2-S1		1.43	0.068	<0.0010	0.0068	0.0019
		S2		2.04	0.052	0.0018	0.0210	0.0057
		S3		2.31	<0.010	0.0034	0.0140	0.0037
3-1	3-1-1-C1			0.025	0.008	<0.0010	0.0155	0.0043
			3-1-T1A	1.56	0.021	0.0040	0.0057	0.0016
			1B	1.56	0.017	0.0011	0.0040	0.0011
			1C	1.24	0.032	0.0170	0.0070	0.0019
			1D	1.00	0.017	<0.0010	0.0110	0.0030
			2A	1.16	0.034	0.0026	0.0072	0.0020
			2B	0.90	0.043	<0.0010	0.0082	0.0022
			2C	1.69	0.010	0.0120	0.0060	0.0016
			2D	1.05	0.011	<0.0010	0.0090	0.0025
			3A	1.65	0.019	0.0044	0.0068	0.0019
			3B	2.15	0.028	0.0042	0.0120	0.0033
			3C	1.39	0.043	<0.0010	0.0072	0.0020
			3D	1.30	0.020	<0.0010	0.0160	0.0044
3-2	3-2-1-C1			1.23	0.027	0.0035	0.035	0.0096
	C2			1.14	0.020	0.0056	0.036	0.0099
	C3			0.99	0.021	0.0017	0.012	0.0033
	C4			1.08	0.024	0.0210	0.010	0.0027
	C5			1.33	0.023	0.0120	0.010	0.0027
	C6			1.10	0.013	0.0019	0.006	0.0016
	C7			0.89	0.025	0.0030	0.012	0.0033
	C8			0.76	0.018	0.0084	0.010	0.0027
	C9			0.79	0.026	0.0057	0.032	0.0088
		3-2-1-S1		1.00	0.026	0.0032	0.0195	0.0051
		S2		1.00	0.026	0.0022	0.0120	0.0033
		S3		1.00	0.020	0.0053	0.0130	0.0036
		S4		1.25	0.018	0.0048	0.0155	0.0042
		S5		0.83	<0.010	0.0036	0.0180	0.0049
		S6		0.95	<0.010	<0.0010	0.0130	0.0036
		S7		0.94	<0.010	0.0022	0.0160	0.0044
		S8		0.60	<0.010	0.0050	0.0170	0.0047
	3-2-2-C1			0.25	0.0195	0.0055	0.0185	0.0051
	C2			1.95	0.0170	0.0023	0.0064	0.0018
	C3			0.32	0.0265	0.0025	0.0195	0.0053
	C4			0.32	0.0195	0.0012	0.0096	0.0026
	C5			0.65	0.0285	0.0025	0.0032	0.0025
	C6			0.23	0.0205	0.0012	0.0086	0.0024
		3-2-2-S1		1.45	0.021	0.0013	0.0140	0.0038
			3-2-T1A	0.84	0.027	0.0020	0.0078	0.0021
			1B	1.11	0.028	0.0020	0.0105	0.0030
			1C	1.50	0.021	<0.0010	0.0310	0.0085
			1D	1.30	0.017	<0.0010	0.0130	0.0044
3-3	3-3-1-C1			0.025	<0.005	<0.0010	<0.003	<0.001
	C2			0.025	<0.005	<0.0010	<0.003	<0.001
	C3			0.025	0.010	<0.0010	0.0040	0.001
	C4			0.025	<0.005	<0.0010	<0.003	<0.001
	C5			0.025	<0.005	<0.0010	0.0045	0.0012
	C6			0.025	<0.005	<0.0010	<0.003	<0.001
	C7			0.025	<0.005	<0.0010	0.0042	0.0011
	C8			0.025	0.010	<0.0010	0.0040	0.001
	C9			0.28	0.015	<0.0010	<0.003	<0.001
	C10			0.10	0.022	<0.0010	<0.003	<0.001
	C11			0.025	0.0125	<0.0010	<0.003	<0.001
	C12			0.025	0.014	<0.0010	<0.003	<0.001
	C13			0.025	0.020	<0.0010	0.0047	0.0013
	C14			0.29	0.019	<0.0010	0.0055	0.0015
	C15			0.035	0.028	<0.0010	<0.003	<0.001
	C16			0.035	0.017	<0.0010	0.018	0.0049
		3-3-1-S1		NIL	0.001	0.0021	0.0160	0.0044
		S2		NIL	0.01	0.0010	0.0130	0.0036
		S3		NIL	0.01	<0.0010	0.0064	0.0018
		S4		NIL	0.01	<0.0010	0.0059	0.0016
		S5		NIL	0.01	0.0010	0.0086	0.0024
		S6		0.005	0.0082	0.0010	0.0100	0.0027
		S7		0.13	0.0090	0.0010	0.0052	0.0014
			3-3-T1A	0.10	0.0280	<0.0010	0.0035	0.0010
			1B	0.10	0.0050	<0.0010	0.0053	0.0015
			1C	0.13	0.0070	<0.0010	0.0076	0.0021
			1D	0.18	0.0090	0.0010	0.0056	0.0016
			1E	0.11	0.0250	0.0016	0.0090	0.0025
3-4	3-4-1-C1			0.13	0.040	<0.0010	0.0120	0.0030
	C2			0.13	0.062	0.0010	0.0150	0.0041
	C3			1.60	<0.01	0.0021	0.0135	0.0037
	3-4-2-C1			0.06	0.043	<0.0010	0.0049	0.0013
	C2			1.13	0.033	0.0068	0.0130	0.0036
	C3			1.13	0.130	0.0010	0.0125	0.0035
	C4			0.61	0.084	0.0060	0.0072	0.0020
	C5			1.01	0.060	0.0010	0.0097	0.0027
	C6			0.50	0.044	0.0010	0.0110	0.0030
	C7			0.10	0.021	0.0019	0.0145	0.0040
	C8			NIL	0.053	0.0030	0.0135	0.0037

Pegmatite Number	Core Sample	Sludge Sample	Trench Sample	Li_2O	BeO	Sn	Cb_2O_5	Ta_2O_5
3-4	3-4-2-C9			0.90	0.039	0.0013	0.0150	0.0041
		3-4-2-S2		1.41	0.043	0.0022	0.0093	0.0025
		S3		0.75	0.034	0.0049	0.0155	0.0043
		S4		0.45	<0.010	0.0015	0.0135	0.0037
		S5		0.56	<0.010	<0.0010	0.0053	0.0015
3-5	3-5-1-C1			0.75	0.026	0.0042	0.0175	0.0048
	C2			1.78	0.020	0.0215	0.0135	0.0037
	C3			1.50	0.020	<0.0010	0.0120	0.0033
	C4			1.15	0.031	<0.0010	0.0190	0.0052
	C5			1.15	0.025	0.0034	0.0120	0.0034
	C6			1.46	0.039	0.0040	0.0086	0.0024
	C7			1.40	0.035	0.0026	0.0079	0.0022
	C8			1.20	0.045	0.0096	0.0160	0.0044
	C9			1.35	<0.010	0.0100	0.0175	0.0048
	C10			0.40	<0.010	0.0013	0.0066	0.0018
		3-5-1-S3		1.20	0.034	0.0150	0.0068	0.0019
		S4		1.33	0.033	0.0100	0.0150	0.0041
		S5		1.33	0.038	0.0019	0.0110	0.0030
		S6		1.65	0.042	0.0019	0.0200	0.0055
		S7		1.40	0.021	0.0011	0.0100	0.0027
		S8		1.23	0.050	0.0130	0.0170	0.0048
		S9		1.13	0.028	0.0100	0.0140	0.3038
	3-5-2-C1			1.15	<0.010	0.0060	0.0175	0.0048
	C2			1.49	<0.010	0.0030	0.0150	0.0041
	C3			0.37	0.024	0.0015	0.0068	0.0019
	C4			1.77	<0.010	0.1300	0.0210	0.0057
	C5			1.68	0.017	<0.0010	0.0060	0.0016
	C6			1.60	<0.010	0.0033	0.0035	0.0010
	C7			2.26	0.037	0.0043	0.0071	0.0020
	C8			1.04	0.038	0.0024	0.0150	0.0042
		3-5-2-S1		1.31	0.013	0.0075	0.0130	0.0036
			3-5-T1A	0.90	0.030	0.0225	0.0140	0.0038
			1B	0.84	0.022	0.0185	0.0130	0.0036
			1C	1.05	0.022	0.0130	0.0183	0.0050
			1D	0.77	0.018	0.0205	0.0120	0.0033
			2A	1.15	0.041	0.0011	0.0103	0.0028
			2B	1.39	0.018	0.0019	0.0123	0.0033
			2C	2.70	0.020	0.0015	0.0102	0.0028
			2D	2.06	0.031	0.0039	0.0190	0.0028
			2E	1.10	0.018	0.0022	0.0125	0.0035
			2F	1.85	0.024	0.0195	0.0163	0.0045
			2G	1.37	0.032	0.0015	0.0545	0.0150
			2H	1.30	0.023	0.0189	0.0120	0.0033
			2I	1.42	0.024	0.0047	0.0123	0.0033
			3A	1.63	0.025	0.0070	0.0143	0.0039
			3B	1.65	0.028	0.0010	0.0135	0.0037
			3C	1.40	0.026	0.0042	0.0140	0.0038
			3D	1.30	0.020	0.0025	0.0195	0.0053
			3E	1.00	0.029	0.0030	0.0135	0.0037
3-6	3-6-1-C1			0.20	0.018	<0.0010	0.0170	0.0047
	C2			0.20	0.006	<0.0010	0.0082	0.0023
	C3			0.88	0.040	0.0020	0.0130	0.0036
	C4			0.48	0.022	0.0023	0.0110	0.0030
	C5			0.77	0.041	0.0160	0.0120	0.0033
	C6			0.20	0.034	0.0012	0.0700	0.0192
	C7			0.20	0.026	0.0900	0.0230	0.0063
3-7	3-7-1-C1			NIL	<0.005	<0.0010	0.0120	0.0030
	2			NIL	<0.005	<0.0010	0.0074	0.0020
	3			NIL	<0.005	0.0011	0.0170	0.0049
	4			NIL	<0.005	0.0010	0.0170	0.0049
	5			NIL	<0.005	0.0011	0.0170	0.0049
	6			NIL	<0.005	<0.0010	0.0105	0.0030
	7			NIL	<0.005	<0.0010	0.0110	0.0039
	8			NIL	<0.005	0.0011	0.0180	0.0050
	9			NIL	<0.005	0.0011	0.0140	0.0038
	10			NIL	<0.005	<0.0010	0.0150	0.0041
	11			NIL	<0.005	0.0011	0.0195	0.0053
	12			NIL	<0.005	<0.0010	0.0125	0.0033
	13			NIL	<0.005	0.0015	0.0200	0.0053
	14			NIL	<0.005	0.0011	0.0190	0.0052
	15			NIL	<0.005	<0.0010	0.0100	0.0028
	16			NIL	<0.005	<0.0010	0.0120	0.0033
	17			NIL	<0.005	0.0019	0.0175	0.0048
	18			NIL	<0.005	<0.0010	0.0086	0.0024
	19			NIL	<0.005	<0.0010	0.0135	0.0037
	20			NIL	<0.005	<0.0010	0.0135	0.0037
	21			NIL	<0.005	<0.0010	0.0100	0.0028
	22			NIL	<0.005	<0.0010	0.0080	0.0023
	23			0.30	0.030	0.0045	0.0115	0.0031
	24			0.13	<0.005	<0.0010	0.0100	0.0028
	25			0.09	0.018	<0.0010	0.0086	0.0024
	26			0.10	<0.005	<0.0010	0.0082	0.0024
	27			0.10	<0.005	0.0016	0.0155	0.0043
	28			0.10	<0.005	<0.0010	0.0135	0.0037
	29			0.10	<0.005	0.0013	0.0150	0.0041
	30			0.10	0.012	0.0012	0.0125	0.0033
	31			0.10	<0.005	<0.0010	0.0105	0.0028
	32			0.10	0.014	<0.0010	0.0100	0.0028
	33			0.10	0.021	0.0014	0.0125	0.0033
	34			0.10	0.025	<0.0010	0.0052	0.0014
	35			0.10	0.014	0.0015	0.0092	0.0052
	36			0.10	0.042	<0.0010	0.0086	0.0024
		3-7-1-S1		NIL	<0.005	<0.0010	0.0065	0.0018
		2		NIL	<0.005	<0.0010	0.0060	0.0017
		3		NIL	<0.005	<0.0010	0.0064	0.0017
		5		NIL	<0.005	<0.0010	0.0070	0.0019
		6		NIL	<0.005	<0.0010	0.0062	0.0017
		7		NIL	<0.005	<0.0010	0.0075	0.0020
		8		NIL	<0.005	0.0012	0.0096	0.0028
		9		0.36	0.010	0.0165	0.0120	0.0033

DISTRIBUTION OF PEGMATITE IN DRILL HOLES

Core Sample	Sludge Sample	4-1-1 From	4-1-1 To	4-1-2 From	4-1-2 To	4-1-3 From	4-1-3 To	4-2-1 From	4-2-1 To	4-3-1 From	4-3-1 To	4-3-2 From	4-3-2 To	3-1-1 From	3-1-1 To
		NO	NE	NO	NE	2.9	7.7	NO	NE	41.7	61.8	23.7	29.5	122.0	123.6
C1	S1					2.9	7.7					23.7	29.5		
C2	S2					7.7	12.7			61.8	69.7	29.5	34.8		
C3	S3					12.7	17.3			71.5	76.6	34.8	38.6		
C4	S4					17.3	22.2			76.6	81.7	39.6	42.9		
C5	S5					22.2	28.2			81.7	86.9				
C6	S6									93.1	97.2				
C7	S7									100.9	103.1				
C8	S8														
C9	S9														
C10															
C11															
C12															
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C33															
C34															
C35															
C36															

Core Sample	Sludge Sample	3-2-1 From	3-2-1 To	3-2-2 From	3-2-2 To	3-3-1 From	3-3-1 To	3-4-1 From	3-4-1 To	3-4-2 From	3-4-2 To	3-5-1 From	3-5-1 To	3-5-2 From	3-5-2 To	3-6-1 From	3-6-1 To	3-7-1 From	3-7-1 To	Sample
C1		75.8	83.6	20.3	22.0	34.9	39.7	16.2	19.8	29.4	32.0	31.5	34.5	16.0	20.0	2.9	7.9	10.0	25.8	C1
	S1	75.8	83.6	29.3	33.9	39.7	49.3							16.0	20.0			113.5	118.5	S1
C2	S2	115.3	120.3	29.3	33.9	39.7	44.5	19.8	23.4	50.5	54.9	34.5	40.9	20.0	25.5	7.9	13.5	25.8	45.8	C2
		115.3	125.3			49.3	54.1			50.5	54.9							118.5	123.5	S2
C3	S3	120.3	125.3	33.9	38.5	44.5	49.3	45.0	48.7	54.9	59.3	40.9	46.0	25.5	30.5	53.2	55.1	45.8	50.4	C3
		125.3	130.3			54.1	58.9			54.9	59.3	40.9	46.0					123.5	128.5	S3
C4	S4	125.3	130.3	38.5	43.1	49.3	54.1			59.3	63.7	46.0	51.0	30.5	35.5	66.1	68.9	50.4	58.1	C4
		130.3	135.3			58.9	63.7					46.0	51.0							S4
C5	S5	130.3	135.3	43.1	47.7	54.1	58.9			65.2	69.0	51.0	56.0	35.5	40.5	72.8	74.4	58.4	63.4	C5
		135.3	140.3			63.7	68.5			65.2	69.0	51.0	56.0					133.5	138.5	S5
C6	S6	135.3	140.3	47.7	52.3	58.9	63.7			112.0	118.0	56.0	61.0	40.5	45.5	91.6	92.8	63.4	68.5	C6
		140.3	145.3			68.5	73.8			112.0	118.0	56.0	61.0					138.5	143.5	S6
C7	S7	140.3	145.3			63.7	68.5			122.5	124.4	61.0	66.0	45.5	50.5			68.5	73.5	C7
		145.3	150.3			119.1	125.1					61.0	66.0					143.5	148.5	S7
C8	S8	145.3	150.3			68.5	73.8			128.3	130.0	66.0	69.8	50.5	53.3			73.5	78.5	C8
		150.3	154.5			125.1	131.1					66.0	69.8					148.5	158.5	S8
C9	S9	150.3	154.5			86.0	86.8			137.4	138.3	87.7	94.0					78.5	83.5	C9
												87.7	94.0					186.0	195.0	S9
C10						107.9	109.1					100.5	101.8					83.5	88.5	C10
C11						113.1	125.1											88.5	93.5	C11
C12						125.1	131.1											93.5	98.5	C12
C13						132.5	133.6											98.5	103.5	C13
C14						137.7	139.6											103.5	108.5	C14
C15						143.0	144.0											108.5	113.5	C15
C16						201.2	204.3											118.5	123.5	C16
C17																		123.5	128.5	C17
C18																		128.5	133.5	C18
C19																		133.5	138.5	C19
C20																		138.5	143.5	C20
C21																		143.5	148.5	C21
C22																		148.5	150.5	C22
C23																		186.0	190.5	C23
C24																		190.5	195.0	C24
C25																		214.0	219.0	C25
C26																		219.0	224.0	C26
C27																		224.0	229.0	C27
C28																		229.0	234.0	C28
C29																		234.0	239.0	C29
C30																		239.0	244.0	C30
C31																		317.0	322.0	C31
C32																		322.0	327.0	C32
C33																		330.0	338.5	C33
C34																		331.0	333.0	C34
C35																		344.5	346.0	C35
C36																		326.0	330.0	C36

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Mineral Content of Pegmatites Computed from Assays

* Only traces detected; See assay table

Sample No. Core	Sludge	Trench	Spodumene at 7.3% Li_2O Each Sample %	Wt. Ave. % Per Peg.	Beryl at 12% BeO Each Sample %	Wt. Ave. % Per Peg.	Cassiterite at 75% Sn Each Sample %	Wt. Ave. % Per Peg.	Columbite-Tantalite at 75% $[Cb_2O_5+Ta_2O_5]$ Each Sample %	Wt. Ave. % Per Peg.
4-1-3-C1			6.71		*		0.0015		0.0152	
C2			—		*		*		0.0123	
C3			1.37	11.69	*	*	0.0023	0.0021	0.0069	0.0273
C4			21.78		*		0.0028		0.0071	
C5			24.79		*		0.0031		0.0123	
	4-1-3-S1		3.81		*		*		0.0110	
4-3-1-C1			1.53		0.80		0.0053		0.0237	
C2			4.93		0.59		0.0016		0.0263	
C3			9.32	9.58	0.59	0.65	0.0048	0.0053	0.0237	0.0260
C4			13.01		0.48		0.0101		0.0200	
C5			21.50		0.38		0.0063		0.0116	
C6			5.21		0.33		0.0173		0.0257	
C7			21.92		0.25		0.0120		0.0253	
4-3-2-C1			16.03		0.32		0.0016		0.0059	
C2			14.25	18.59	*	0.09	0.0021	0.0012	0.0123	0.0270
C3			23.15		*		0.0045		0.0827	
C4			23.42		*		0.0191		0.0105	
	4-3-2-S1		13.59		0.51		*		0.0116	
	S2		27.96		0.43		0.0024		0.0556	
	S3		31.61		*		0.0045		0.0236	
3-1-1-C1			3.42		0.07		*		0.0252	
		3-1-T1A	21.36		0.18		0.0055		0.0097	
		1B	21.36	18.35	0.14	0.18	0.0015	0.0074	0.0068	0.0117
		1C	16.99		0.27		0.0226		0.0119	
		1D	13.70		0.14		*		0.0187	
		2A	17.26		0.28		0.0035		0.0123	
		2B	12.33	16.78	0.17	0.16	*	0.0049	0.0133	0.0129
		2C	23.15		0.08		0.0160		0.0101	
		2D	14.30		0.09		*		0.0153	
		3A	27.60		0.15		0.0059		0.0114	
		3B	23.45	22.91	0.23	0.23	0.0053	0.0029	0.0204	0.0179
		3C	13.04		0.36		*		0.0123	
		3D	20.55		0.11		*		0.0222	
3-2-1-C1			16.85		0.23		0.0047		0.0175	
C2			15.62		0.17		0.0025		0.0180	
C3			13.56		0.18		0.0023		0.0260	
C4			14.79		0.18		0.0280		0.0049	
C5			18.22	13.90	0.19	0.18	0.0160	0.0033	0.0243	0.0178
C6			15.07		0.16		0.0025		0.0223	
C7			12.19		0.21		0.0040		0.0260	
C8			10.11		0.15		0.0112		0.0243	
C9			10.82		0.22		0.0016		0.0160	
	3-2-1-S1		13.90		0.22		0.0013		0.0315	
	S2		13.70		0.22		0.0029		0.0204	
	S3		13.70		0.17		0.0071		0.0221	
	S4		17.12		0.15		0.0064		0.0263	
	S5		11.31		*		0.0048		0.0305	
	S6		13.01		*		*		0.0221	
	S7		12.88		*		0.0029		0.0212	
	S8		8.43		*		0.0067		0.0289	
3-2-2-C1			3.42		0.16		0.0073		0.0308	
C2			14.38		0.14		0.0013		0.0112	
C3			4.38		0.22		0.0029		0.0310	
C4			4.38	7.04	0.16	0.18	0.0016	0.0027	0.0163	0.0189
C5			8.90		0.23		0.0033		0.0156	
C6			3.15		0.11		0.0016		0.0147	
	3-2-2-S1		19.86		0.23		0.0097		0.0231	
		3-2-T1A	11.50		0.37		0.0027		0.0132	
		1B	15.20	16.26	0.38	0.32	0.0027	0.0013	0.0180	0.0264
		1C	20.55		0.29		*		0.0527	
		1D	17.81		0.23		*		0.0220	
3-3-1-C1			3.42		*		*		*	
C2			3.42		*		*		*	
C3			3.42		0.08		*		0.0055	
C4			3.42	3.42	*	0.02	*	*	*	0.0038
C5			3.42		*		*		0.0076	
C6			3.42		*		*		*	
C7			3.42		*		*		0.0011	
C8			3.42		0.08		*		0.0055	
C9			3.91		0.13		*		*	
C10			1.31		0.18		*		*	
C11			3.42		0.10		*		*	
C12			3.42	3.56	0.12	0.13	*	*	*	0.0030
C13			3.42		0.17		*		0.0080	
C14			3.91		0.16		*		0.0033	
C15			4.73		0.23		*		*	
C16			4.73		0.14		*		0.0039	
	3-3-1-S1		*		0.003		0.0078		0.0222	
	S2		*		0.003		0.0013		0.0221	
	S3		*		0.008		*		0.0103	
	S4		*		0.003		*		0.0039	
	S5		*		0.008		0.0013		0.0171	
	S6		0.68		0.048		0.0013		0.0169	
	S7		1.78		0.075		0.0013		0.0088	
		3-3-T1A	1.37		0.06		*		0.0081	
		1B	1.37		0.23		*		0.0060	
		1C	1.78		0.09		*		0.0139	
		1D	2.19		0.12		0.0013		0.0086	
		1E	1.37		0.34		0.0021		0.0175	
3-4-1-C1			1.78	1.78	0.33	0.43	*	0.0007	0.0204	0.0223
C2			1.78		0.22		0.0013		0.0235	
C3			21.92		*		0.0028		0.0229	
3-4-2-C1			0.82		0.36		*		0.0083	
C2			16.16		0.22		0.0091		0.0221	
C3			16.16	13.91	1.08	0.67	0.0013	0.0325	0.0207	0.0181
C4			9.45		0.70		0.1013		0.0123	
C5			13.93		0.50		0.0013		0.0165	
C6			0.68		0.37		0.0013		0.0187	
C7			1.37		0.13		0.0025		0.0247	
C8			*		0.44		0.0090		0.0229	

Sample No. Core	Sludge	Trench	Spodumene at 7.3% Li_2O Each Sample %	Wt. Ave. % Per Peg.	Beryl at 12% BeO Each Sample %	Wt. Ave. % Per Peg.	Cassiterite at 75% Sn Each Sample %	Wt. Ave. % Per Peg.	Columbite-Tantalite at 75% $[Cb_2O_5+Ta_2O_5]$ Each Sample %	Wt. Ave. % Per Peg.
3-4-2-C9			12.32		0.33		0.0019		0.0255	
	3-4-2-S2		17.32		0.34		0.0029		0.0151	
	S3		10.21		0.70		0.0035		0.0269	
	S4		10.21		*		0.0010		0.0229	
	S5		1.67		*		*		0.0091	
3-5-1-C1			10.21		0.22		0.0058		0.0234	
C2			24.58		0.17		0.0020		0.0223	
C3			20.54		0.17		*		0.0209	
C4			15.75		0.26		*		0.0323	
C5			15.75	17.73	0.21	0.21	0.0015	0.0010	0.0206	0.0225
C6			20.00		0.23		0.0053		0.0147	
C7			10.18		0.28		0.0035		0.0135	
C8			16.94		0.38		0.0028		0.0272	
C9			18.93		*		0.0333		0.0297	
C10			5.48		*		0.0011		0.0112	
	3-5-1-S3		16.94		0.28		0.0600		0.0114	
	S4		18.22		0.28		0.0135		0.0252	
	S5		18.22		0.32		0.0025		0.0181	
	S6		22.60		0.35		0.0125		0.0349	
	S7		18.18		0.18		0.0015		0.0163	
	S8		16.35		0.42		0.0175		0.0231	
	S9		16.30		0.23		0.0255		0.0257	
3-5-2-C1			15.15		*		0.0080		0.0297	
C2			20.41		*		0.0010		0.0255	
C3			15.20		0.20		0.0020		0.0116	
C4			24.25		*		0.1733		0.0356	
C5			23.01	20.97	0.35	0.35	*	0.0260	0.0101	0.0295
C6			21.92		*		0.0049		0.0175	
C7			30.35		0.31		0.0057		0.0121	
C8			14.25		0.22		0.0082		0.0256	
	3-5-2-S1		17.95		0.11		0.0160		0.0221	
		3-5-T1A	12.33		0.41		0.0300		0.0237	
		1B	11.50	12.19	0.30	0.31	0.0247	0.0258	0.0221	0.0295
		1C	14.38		0.30		0.0123		0.0311	
		1D	10.55		0.21		0.0223		0.0204	
		2A	15.95		0.29		0.0015		0.0175	
		2B	19.01		0.25		0.0040		0.0208	
		2C	16.93		0.21		0.0020		0.0173	
		2D	28.22		0.57		0.0040		0.0171	
		2E	15.07	21.83	0.25	0.33	0.0023	0.0125	0.0211	0.0284
		2F	25.34		0.53		0.0260		0.0277	
		2G	18.06		0.44		0.0020		0.0227	
		2H	17.81		0.52		0.0040		0.0204	
		2I	19.45		0.33		0.0063		0.0208	
		3A	22.53		0.37		0.0035		0.0243	
		3B	22.60		0.58		0.0013		0.0229	
		3C	13.18	19.12	0.36	0.35	0.0036	0.0097	0.0231	0.0254
		3D	17.81		0.27		0.0031		0.0331	
		3E	13.20		0.40		0.0040		0.0229	
3-6-1-C1			2.74	2.74	0.15	0.10	*	*	0.0289	0.0210
C2			2.74		0.05		*		0.0110	
C3			12.05		0.33		0.0021		0.0221	
C4			6.58		0.13		0.0033		0.0187	
C5			10.55		0.34		0.0243		0.0204	
C6			2.74		0.23		0.0016		0.0189	
C7			2.74		0.22		0.1100		0.0331	
3-7-1-C1			NIL		*		*		0.0204	
C2			NIL		*		*		0.0125	
C3			NIL		*		0.0014		0.0232	
C4			NIL		*		0.0013		0.0232	
C5			NIL		*		0.0014		0.0292	
C6			NIL		*		*		0.0180	
C7			NIL		*		*		0.0187	
C8			NIL		*		0.0014		0.0397	
C9			NIL		*		0.0014		0.0238	
C10			NIL		*		*		0.0255	
C11			NIL	NIL	*	*	0.0014	0.005	0.0331	0.0202
C12			NIL		*		*		0.0214	
C13			NIL		*		0.0020		0.0358	
C14			NIL		*		0.0014		0.0323	
C15			NIL		*		*		0.0171	
C16			NIL		*		*		0.0204	
C17			NIL		*		0.0025		0.0238	
C18			NIL		*		*		0.0171	
C19			NIL		*		*		0.0229	
C20			NIL		*		*		0.0329	
C21			NIL		*		*		0.0171	
C22			NIL		*		*		0.0137	
C23			4.12	2.95	0.15	0.13	0.0040	0.0030	0.0195	0.0183
C24			1.78		*		*		0.0171	
C25			1.23		0.15		*		0.0147	
C26			1.37		*		*		0.0142	
C27			1.37	1.34	*	0.041	0.0021	0.0009	0.0264	0.0219
C28			1.37		*		*		0.0299	
C29			1.37		*		0.0017		0.0255	
C30			1.37		0.10		0.0016		0.0211	
C31			1.37		*		*		0.0178	
C32			1.37	1.37	0.12	0.13	*	0.0001	0.0171	0.0192
C33			1.37		0.18		0.0019		0.0211	
C34			1.37		0.21		*		0.0088	
C35			1.37		0.12		0.0020		0.0192	
C36			1.37		0.35		*		0.0147	
	3-7-1-S1		NIL		*		*		0.0111	
	S2		NIL		*		0.0013		0.0103	
	S3		NIL		*		*		0.0108	
	S5		NIL		*		*		0.0119	
	S6		NIL		*		*		0.0103	
	S7		NIL		*		*		0.0127	
	S8		NIL		*		0.0016		0.0166	
	S9		6.03		0.03		0.0220		0.0294	

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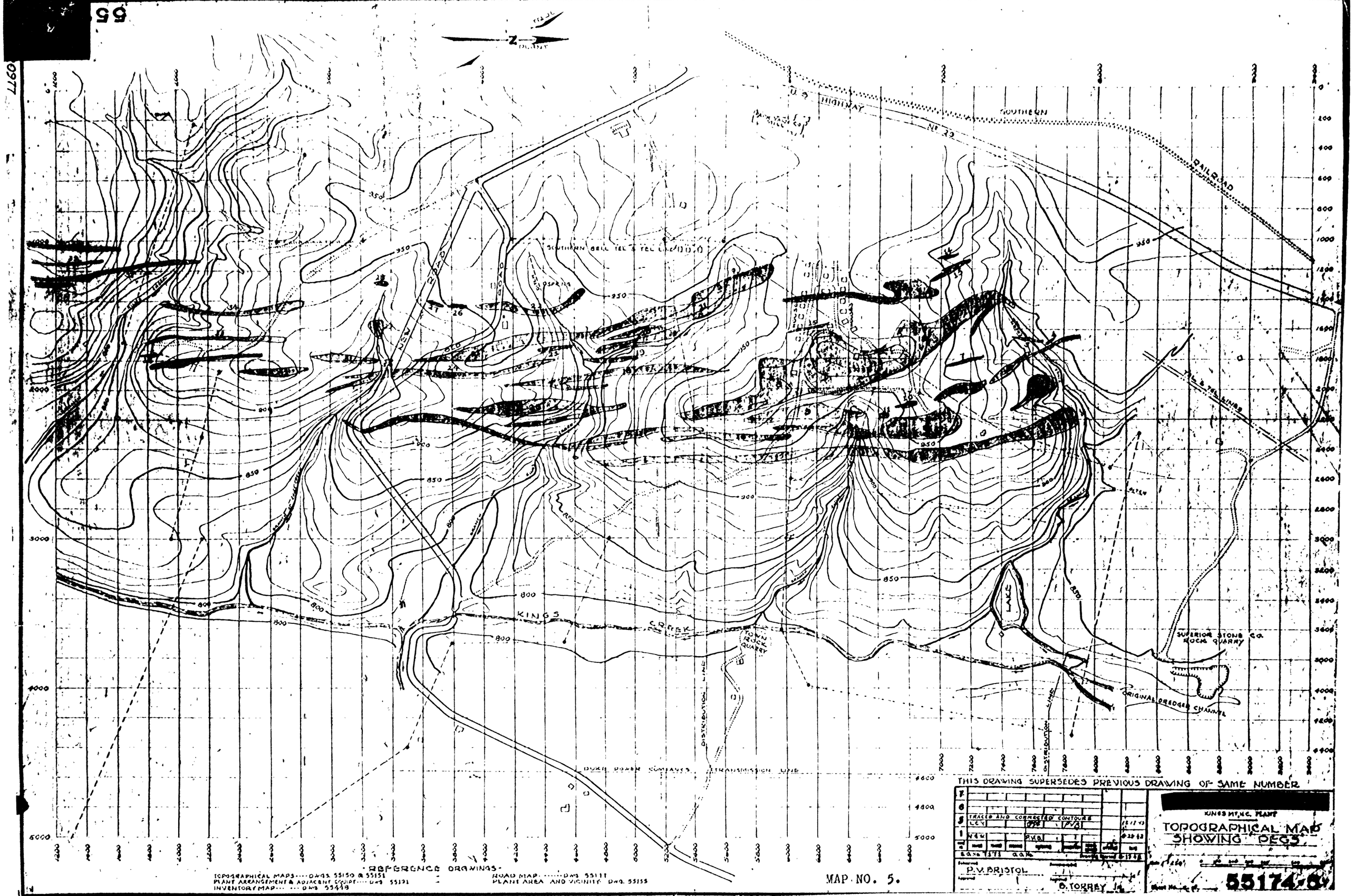
Table 18.--Tin deposits known and reported in the Carolina belt 1/

Number of deposit on pl. 38	Plate showing deposit	Name or location	Type of ore body 2/	Thickness (inches)	Strike length (feet)	Pitch length (feet)	Type of wall rock 3/	Strike of wall rock	Dip of wall rock	Attitude of ore body 4/	Maximum depth of workings (feet)	References 5/ and remarks
1	.....	S. T. Carpenter	G	.....	.....	....	M	.....	.....	...	.....	.....
2	41	Ka-Mi-Tin Concentrating Co.	G	24	9+	....	M	N. 15° E.	65° NW.	C	10	.....
3	41	....do....(Swamp shaft No. 1)	.....	72	30	....	...	.....	.....	...	70	Inaccessible. Information from Stuart St. Clair.
4	41	....do....(Jake open cut)	G	6	10±	....	M	Variable	SW. and NW.	C	.....	Minor showing of ore 200 ft. to the southeast.
5	41	....do....(Condon shaft)	.....	.....	.....	....	M	NE. ?	NW. ?	...	140 ?	Eight thin bodies in adjacent open cuts. (3) Pp. 21-22. (5) P. 73.
6	.....	0.3 mile south of Condon shaft	G	.....	.....	....	M	.....	.....	...	.....	.....
7	.....	Henry shaft	.....	12-24	.....	....	M	NW.	75° SW. ?	C ?	60	(5) P. 21. Only float ore seen in 1940.
8	.....	J. Mostellar	G	.....	.....	....	M and H	N. 10° E. to N. 8° W.	65° NW. to 63° SW.	...	.....	.....
9	.....	Old Well shaft	.....	.....	.....	....	M	N. 17° E.	Steep NW.	...	65 ft. to water	.....
		Ka-Mi-Tin Concentrating Co.	G	5	.....	....	M	N. 18° W.	62° SW.	C	.....	.....
10	.....	Upper Mostellar cut	G (2)	4, 6	.....	....	M	Variable	Variable	C	20	Ore associated with unconformable pegmatite body.
11	.....	J. E. Gates	.....	.....	.....	....	M	N. 33° E.	65° NW.	...	30	Ore reported found in well. Occurs in gully near well, and as float 250 ft. northwest of well.
12	40	Metcalf prospect	G and F	1½, 6, 18	All 9+	....	H	N. 65° E.	65° NW.	U	20	Greisen gangue, 18-in. body. Feldspathic gangue, 1½- and 6-in. bodies. Two occurrences of float ore to the northwest.
13	40	1,550 ft. N. 70° W. from Metcalf prospect	G	.....	.....	....	H	NE.	NW.	...	.....	.....
14	.....	J. M. L. Carpenter	G	.....	.....	....	M	N. 47° E.	72° NW.	C ?	40	Shaft inaccessible.
		Paul Hastings	.....	.....	.....	....	...	.....	.....	...	.....	Pit 18 ft. deep reported sunk on ore in summer of 1940. Information from Julian S. Jacobs.
15	.....	T. S. Hastings	G	.....	.....	....	M	N. 55° E.	62° NW.	C ?	14	Shaft inaccessible.
16	40	Allen prospect	G	24	20+	....	M and H	N. 85° E.	73° NW.	U	2	(6) Pp. 145-146. Also float ore 750 ft. N. 25° W.
		Baldwin prospect	G	.....	.....	....	H	NE.	NW.	...	45	Early work, results unknown.
17	40	2,225 ft. N. 70° W. from Allen prospect	G (2)	.....	.....	....	H	NE.	NW.	...	.....	Two occurrences within strike distance of 175 ft.
18	40	Vicinity of Jenkins farm	G	.....	.....	....	M and H	NE.	NW.	...	.....	Five ore bodies, indicated by float ore, within radius of 800 ft.
19	40	J. W. Whitesides	G	24	.....	....	M	N. 50° E.	70° NW.	C	3	Ore also reported found in adjacent shallow shaft.
		L. A. C. Kizer	G	24	.....	....	M	N. 35° E.	35° NW.	C	10	Ore seen in place, 1939. Pit since filled.
20	.....	Fred Mauney and Gus Clark farms	G	.....	.....	....	M and H	.....	.....	...	.....	1/4 mile apart; float ore found.
21	.....	Julia Weathers	G (2)	4, 18	.....	....	M	N. 8° E.	48° NW.	C	3	Float ore richer than that in place.
22	.....	Pink Wright	G	.....	.....	....	M	.....	.....	...	.....	.....
23	.....	Jones mine	G and F	"Few" to 48	20-50	125±	H	N. 30° E.	55° NW.	U	175	(1) Pp. 29-30. (2) Pp. 46-48, 53-54. (3) P. 20.
24	.....	Seaman prospect	.....	.....	.....	....	M	N. 15° W.	45° SW.	...	45 ?	Shaft inaccessible.
25	.....	Holland prospect	G	4 ?	.....	....	M	N. 70° E. ?	.....	...	9+	.....
26	.....	Ramseur Mill prospect	G	12-24 ?	.....	....	H	N. 27° E.	55° NW.	U ?	30	(3) P. 29. (6) Pp. 143-144. Only float ore seen in 1940.
27	.....	M. V. Hovis prospect	G	.....	.....	....	H	N. 60° E.	65° NW.	...	35	Shaft inaccessible.
28	.....	E. A. Berry	G	.....	.....	....	M and H	N. 10° W.	50° SW.	...	.....	.....
29	.....	J. A. Ormond	.....	.....	.....	....	...	.....	.....	...	.....	Shallow pit reported to have encountered a little ore in 1936; now filled. No ore seen in 1940.
30	.....	Ormond-Carr prospect	G and F	3-6	.....	....	M and H	.....	.....	...	8+	Shaft inaccessible.
31	.....	Cole farm	G	.....	.....	....	M and H	.....	.....	...	.....	.....
32	.....	Kizer-Mauney farm	.....	.....	.....	....	...	.....	.....	...	.....	No ore seen in 1940. Earlier discovery reported.
33	.....	M. Ormond farm	G	.....	.....	....	M ?	.....	.....	...	.....	.....
34	.....	John Plonk farm	G	.....	.....	....	M	N. 20° E.	60° NW.	C ?	8	.....
35	.....	J. C. Horton shaft	.....	.....	.....	....	M	N. 13°-23° E.	63°-70° NW.	...	122 ?	(1) P. 28. Shaft inaccessible.
36	.....	Frank Summers farm	G	.....	.....	....	...	.....	.....	...	.....	Float ore.
37	.....	Mauney Park	G	6 (24?)	.....	....	M and H	N. 5° E.	Vertical	C	5±	(6) Pp. 142-143.
38	.....	Kings Mountain mine	.....	.....	.....	....	M and H	Variable	Variable	...	75 (160?)	Float ore found in 1940, 450 ft. S. 70° W. of main shaft.
39	.....	Occurrences reported in town of Kings Mountain, now hidden by buildings and pavements:										
		(a) Property of O. W. Meyers, 112 N. Piedmont Ave. (formerly Captain Suggs place).	.....	.....	.....	....	...	.....	.....	...	.....	Ore body reported in well.
		(b) Near Post Office.	.....	.....	.....	....	...	.....	.....	...	.....	Tunnel reported to have cut ore body.
		(c) Short distance south of end of West Gold St.	.....	.....	.....	....	...	.....	.....	...	.....	Early discovery of cassiterite "in granite" reported.
40	.....	0.15 mile southeast of Bonnie Mill	.....	.....	.....	....	M and H	NE.	NW.	...	.....	Cassiterite float.
41	.....	Falls prospect	G	24	.....	....	M	N. 35° E.	60° NW.	C	15+	No ore seen in 1940. (1) P. 26. (6) Pp. 138-139.
42	39	Faires mine	G and F (2)	Variable	.....	....	H mostly	N. 35° E.	75° NW.	C	40	(2) Pp. 48-49.
43	39	435 ft. northeast of Faires main shaft	G and F	9-18	.....	....	M	N. 35° E.	70° NW.	C	10	.....
44	39	Atlas shaft	F	24	.....	....	M	N. 25° E.	60° NW.	C	125	Cassiterite float found 575 feet N. 57° W. of shaft.
45	39	1,825 ft. southwest of Faires main shaft	G	.....	20±	....	M	N.	W.	C	.....	350 ft. northeast of Miller residence. Trench now filled.
46	39	Mike Plonk prospect	G	42	9+	....	M	N. 32° E.	50° NW.	C	.....	Float ore seen within 200 ft. southwest.
47	39	1,350 ft. northwest of Plonk prospect	G	.....	.....	....	...	.....	.....	...	.....	.....
48	39	2,000 ft. S. 55° E. of Park Yarn mill	G and F	.....	.....	....	M and H	NE.	NW.	...	85	North end of a series of six exposed ore bodies prospected by A. R. Ledoux in 1888-89, and later by Blue Ridge Tin Corporation. Thickest body reported 3 ft. Maximum seen in 1939, 2 ft. Maximum strike length possibly 275 ft. Thickness and grade known to be uneven in all. Two occurrences of float ore. See map, plate 39. (6) P. 140.. (1) Pp. 24-26.
49	39	2,825 ft. S. 10° E. of Park Yarn mill	G (2)	Each less than 6	.....	....	M	NE.	NW.	C	.....	.....
50	39	3,300 ft. due south of Park Yarn mill	G and F	.....	.....	....	M and H	NE.	NW.	...	130	North end of a series of five exposed ore bodies prospected by Blue Ridge Tin Corporation about 1897. One may have had a strike length of 250 ft.; maximum thickness is 4 ft., minimum thickness 10 in. in two exposures; grade uneven. Other four bodies much smaller. See map, plate 39. (6) P. 141.
51	39	1,675 ft. S. 60° E. of Compact School	G	4-12	75 ?	....	M	N. 25° E.	75° NW.	C	3	.....
52	39	3,000 ft. S. 64° E. of Compact School	.....	.....	.....	....	...	NE.	NW.	...	.....	Float pegmatite, and grains of cassiterite, columbite, and andalusite in soil residual from crystalline limestone.
53	39	3,025 ft. S. 3° E. of Compact School	G	6	.....	....	M	N. 20° E.	65° NW.	C	.....	.....
54	39	3,550 ft. from Hwy. 29 along Dixon School road	G	1.5	.....	....	M	N. 40° E.	60° NW.	U	.....	Exposed in 2½-ft. gully.
55	39	215 ft. west of locality 54	F	6	.....	....	H	N. 30° E.	60° NW.	...	.....	25 ft. north of spodumene prospect.
56	39	Ross prospect	G	.....	.....	....	M	N. 60° E.	70° NW.	...	3	.....
57	39	1,475 ft. S. 47° W. of locality 56	G	6	.....	....	M	N. 45° E.	60° NW.	C	2	.....
58	.....	J. Patterson farm	G	.....	.....	....	M	N. 45° E.	65° NW.	C	7	Opening filled. Ore seen only as float in 1940. Float ore also found 1,300 ft. northeast, at north end of prominent pegmatite.
59	.....	Shiloh Church	G	2	25 ?	....	M and H	N. 75° E.	70° NW.	Variable	.....	Ore in west bank of road.
60	42	Ross mine	F	Compound 24-108	107 ?	200±	H	N. 46° E. (average)	53° SE. (average)	C	121	(1) Pp. 22-24. (2) Pp. 49-50, 54. (4) Pp. 85-93. No ore in place now exposed.

U. S. GOVERNMENT PRINTING OFFICE: 1942 O - 471319

1/ Names of deposits are based on local sources of information.
2/ G, greisen gangue; F, feldspathic gangue. (2) indicates two ore bodies.
3/ M, muscovite schist or fine-grained gneiss; H, hornblende gneiss.
4/ C, conformable with attitude of wall rock; U, unconformable.
5/ Information published by earlier investigators and impossible to verify in this investigation. Numbers in parentheses indicate references listed below:

(1) Pratt, J. H., and Sterrett, D. B., The tin deposits of the Carolinas: North Carolina Geol. Survey Bull. 19, 1904.
(2) Graton, L. C., A reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, 1906.
(3) Pratt, J. H., The mining industry in North Carolina during 1905: North Carolina Geol. Survey Econ. Paper 11, 1907.
(4) Sloan, Earle, Catalogue of the mineral localities of South Carolina: South Carolina Geol. Survey, ser. 4, Bull. 2, 1908.
(5) Pratt, J. H., The mining industry in North Carolina during 1911 and 1912: North Carolina Geol. Survey Econ. Paper 34, 1914.
(6) Keith, Arthur, and Sterrett, D. B., Tin resources of the Kings Mountain district, N. C. and S. C.: U. S. Geol. Survey Bull. 660-D, 1917.


N
U.S. HIGHWAY NO. 29
SOUTHERN RAILROAD
NEW ROAD
OLD ROAD
SOUTHERN BELL TEL & TEL CO.
KINGS CREEK
TOWN ROCK QUARRY
LAKE
SUPERIOR STONE CO. ROCK QUARRY
ORIGINAL DREDGED CHANNEL
DISTRIBUTION LINE
DUKE POWER COMPANY TRANSMISSION LINE
THIS DRAWING SUPERSEDES PREVIOUS DRAWING OF SAME NUMBER
TRACED AND CORRECTED CONTOURS
P.V.B.
P.V. BRISTOL
D. TORREY Jr.
KINGS MT., N.C. PLANT
TOPOGRAPHICAL MAP SHOWING PEGS
55174-6
MAP NO. 5.
REFERENCE DRAWINGS
TOPOGRAPHICAL MAPS ---- DWG. 55150 & 55151
PLANT ARRANGEMENT & ADJACENT COMPT. ---- DWG. 55121
INVENTORY MAP ---- DWG. 55119
ROAD MAP ---- DWG. 55111
PLANT AREA AND VICINITY DWG. 55155

Foote Mineral Co.,
18 W. Chelten Ave.,
Philadelphia 44, Pa.

EXHIBIT 5. (b)

DRILL HOLES

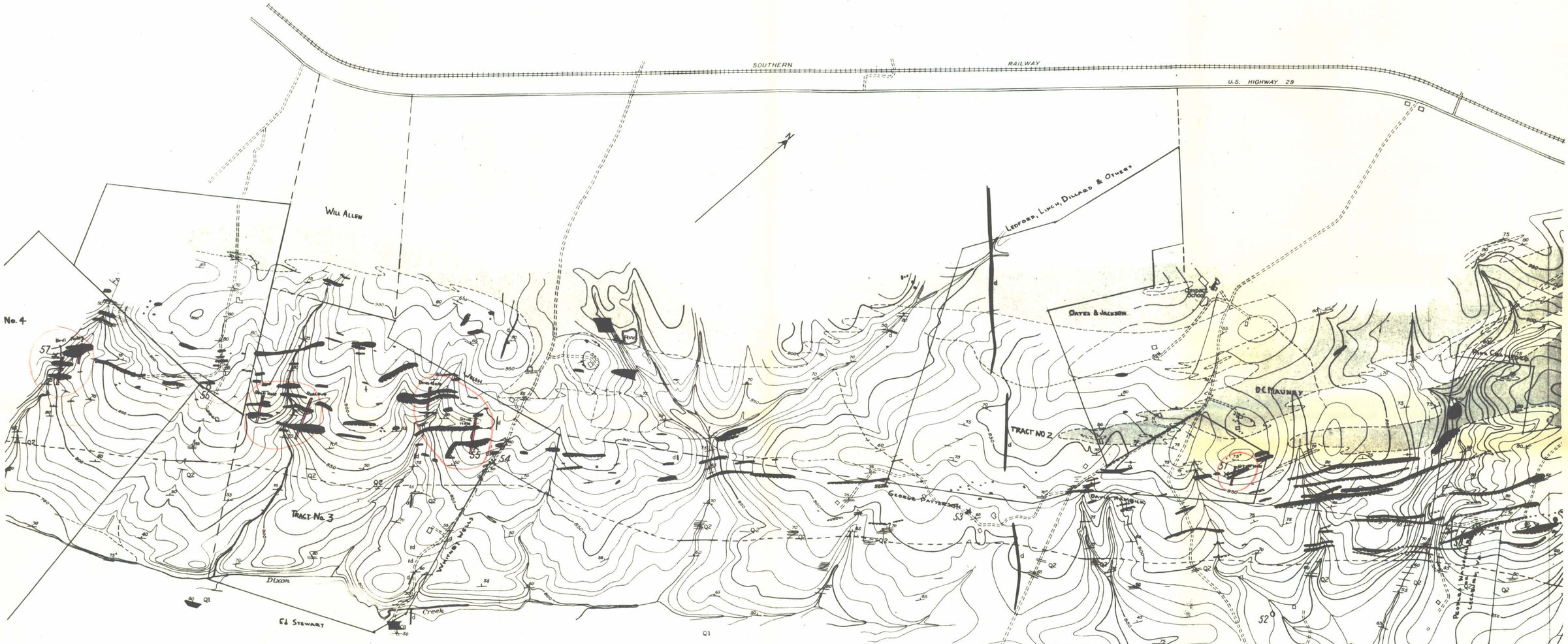
Location	No. Holes	Footage
57	2 at 300 feet	600
North of 56	1 at 400 feet 1 at 300 feet	700
55	1 at 200 feet 1 at 400 feet	600
51	1 at 200 feet	200
		2100

Channel Samples

Location	Footage
57	600
North of 56	640
55	750
51	150
	2140 feet

ED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

No. 4



EXPLANATION

Triassic diabase

Pegmatite, probably Carboniferous
(Contains spodumene where paralleled by black dashed line)

Granitic gneiss, probably Carboniferous

Metamorphic rocks
(Includes crystalline limestone, mica schists and gneisses, and hornblende gneiss. Heavy dashed line shows approximate northwestern limit of crystalline limestone not wholly altered to hornblende gneiss; solid line shows places where limit was determined accurately)

Quartzite outcrop
Q 1 lower zone
Q 2 upper zone

Tin ore exposed in place

Tin ore reported from previous prospecting and mining

Tin ore float near source

Strike and dip of beds and foliation

Strike of vertical beds and foliation

The locality numbers are used in plate 38 and table 18

DRILL HOLE

500 0 5,000 Feet

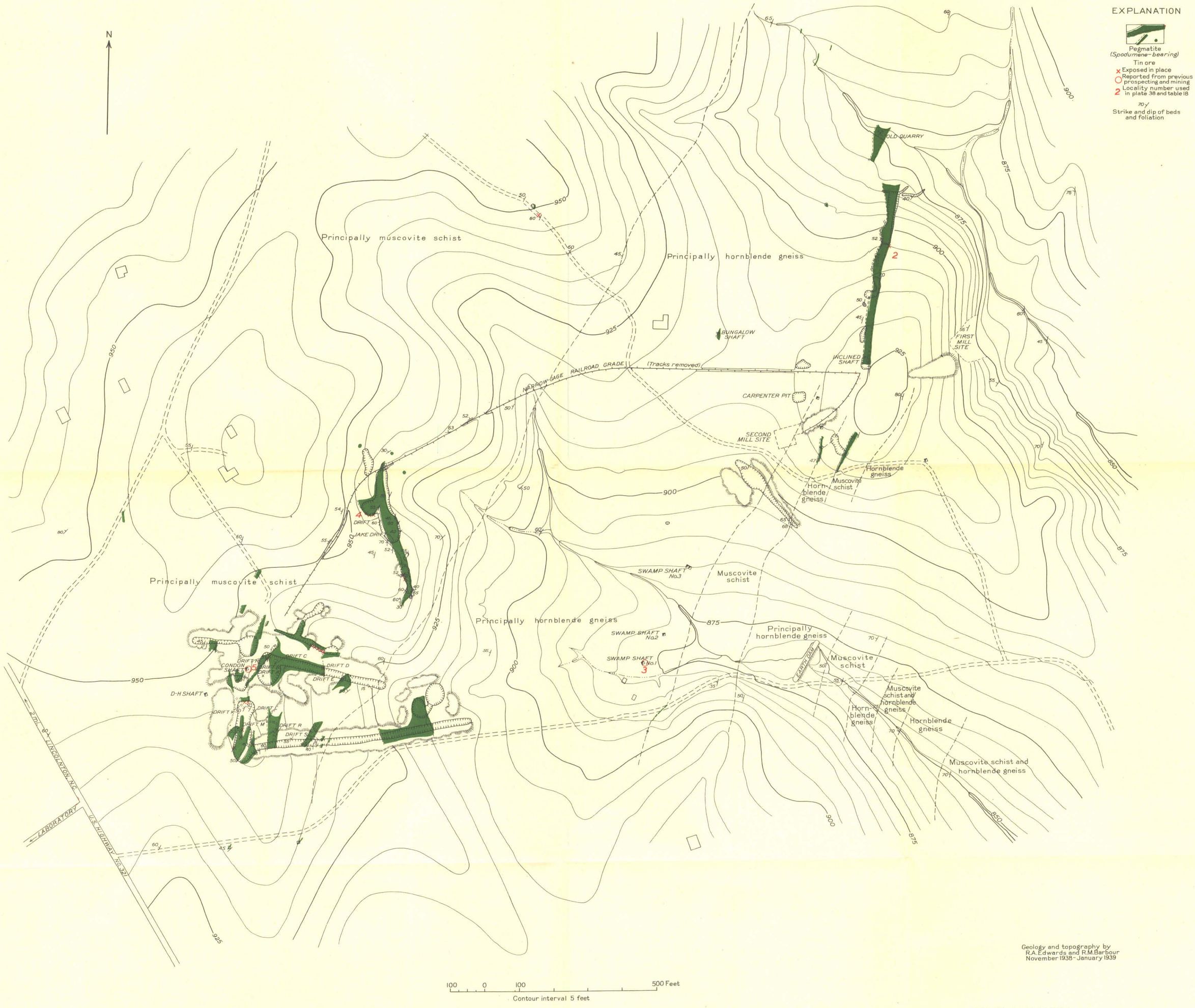
Contour interval 10 feet
Datum is mean sea level

1942

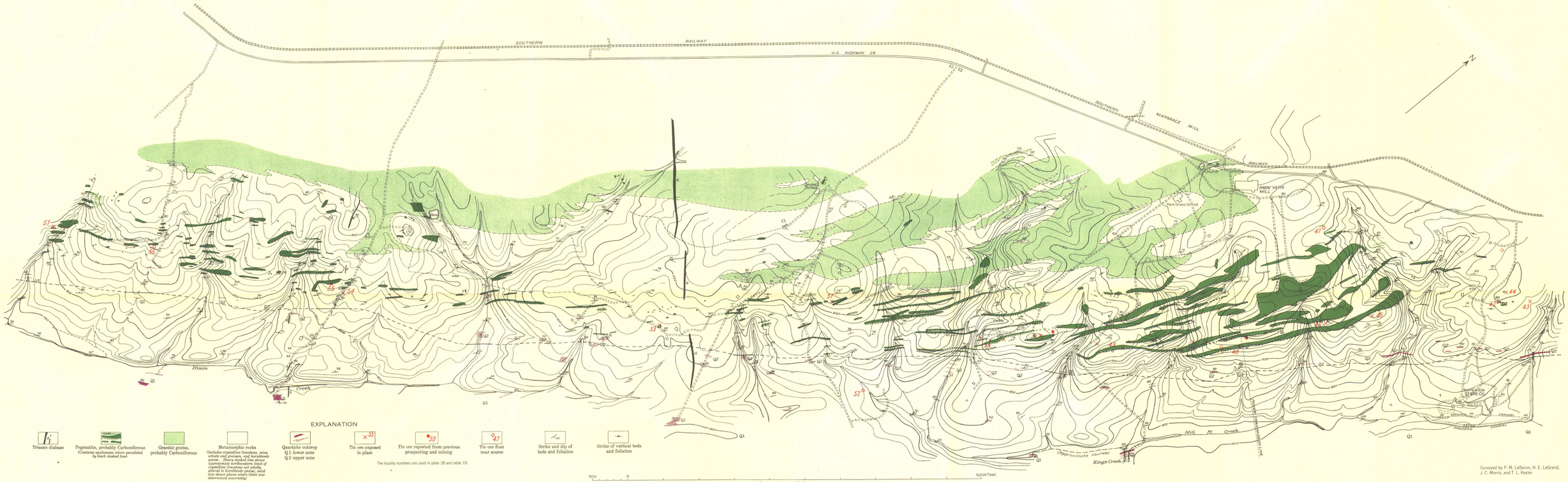
GEOLOGIC MAP OF PART OF THE TIN-SPODUMENE BELT SOUTHWEST OF KINGS MOUNTAIN, NORTH CAROLINA

This is from Plate 39, U.S. Geol. Survey Bull 936J

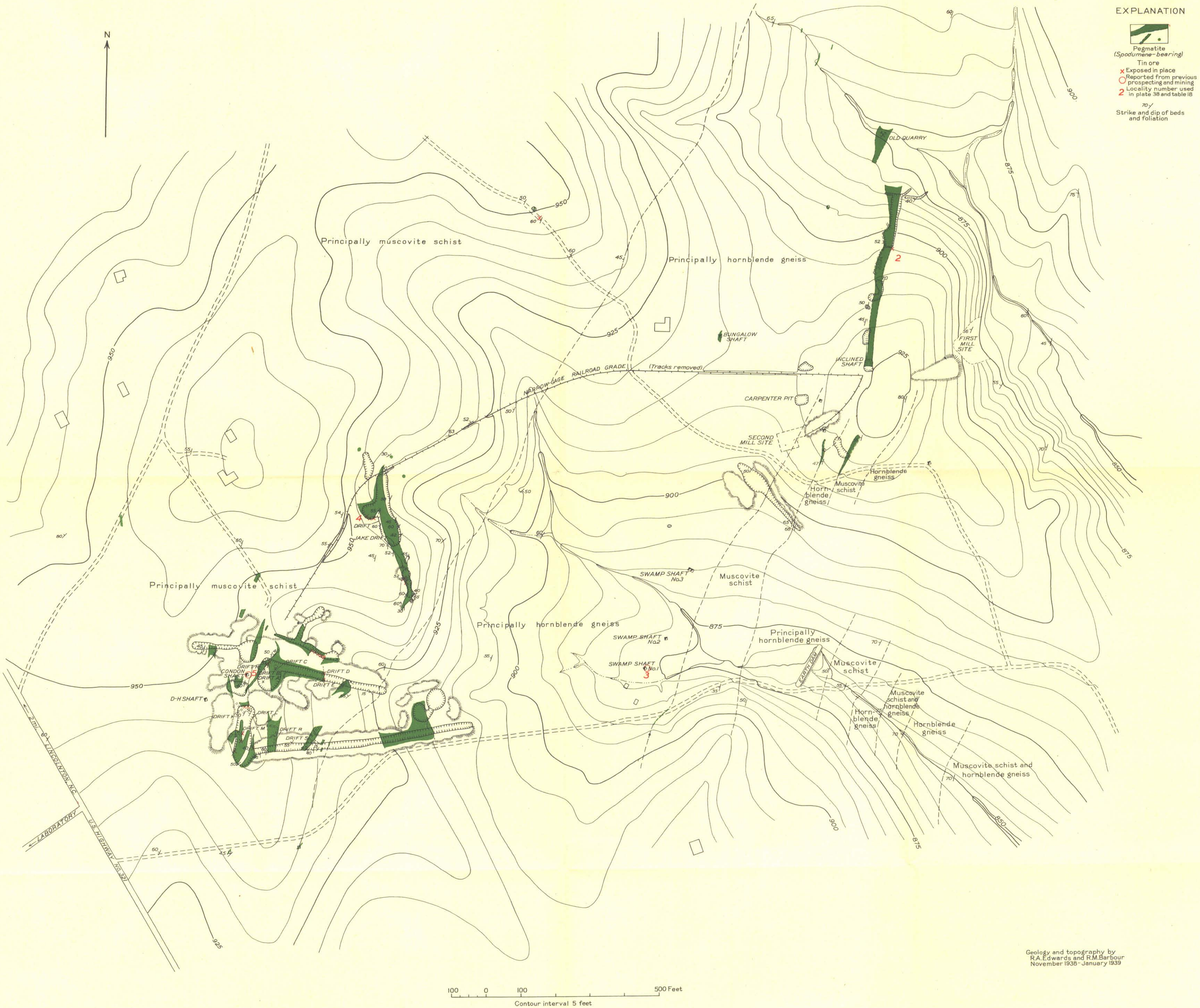
Exhibit 5B



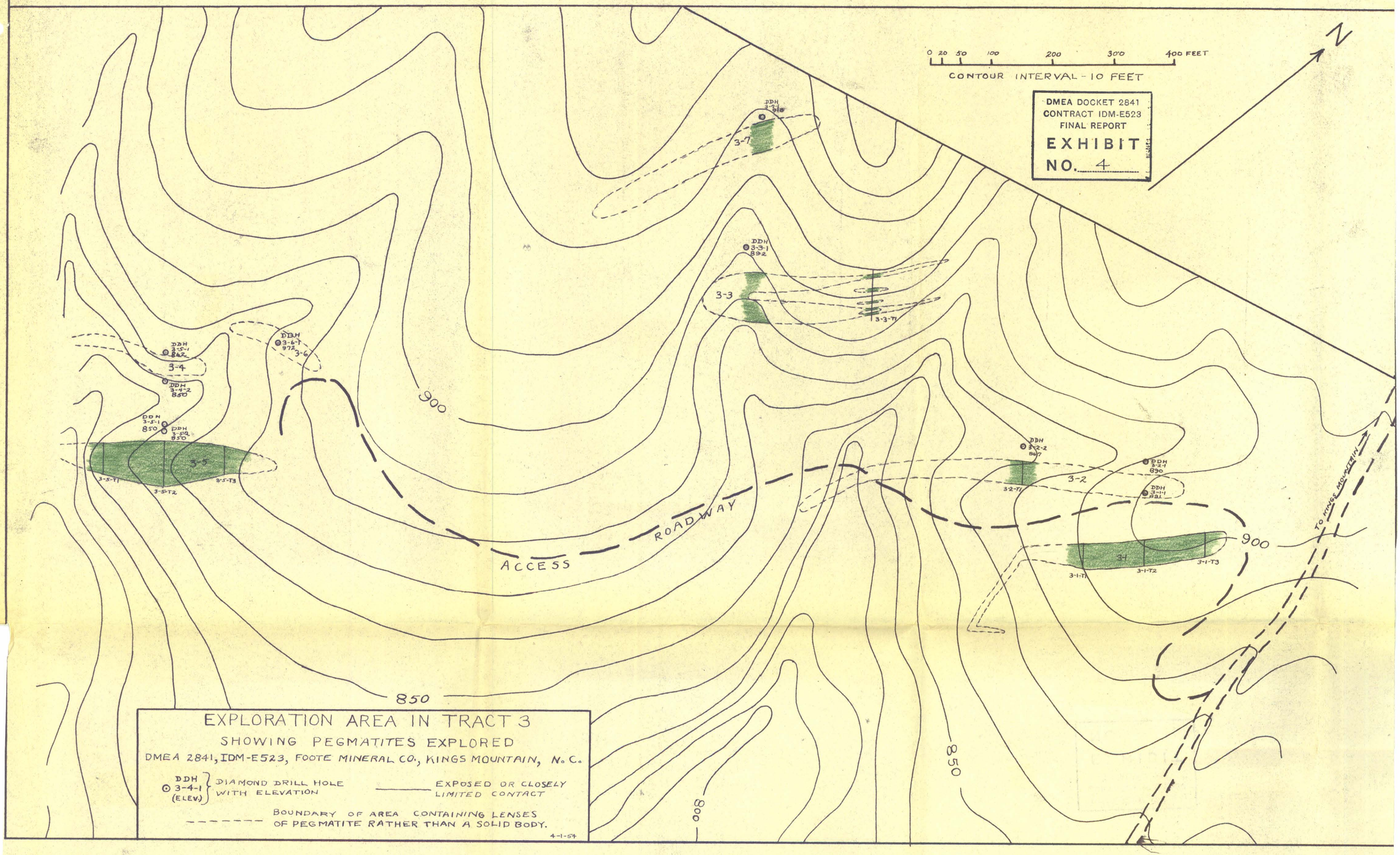
PLAN OF WORKINGS AND PEGMATITE BODIES EXPOSED ON PROPERTY OF THE KA-MI-TIN CONCENTRATING CO., 2 MILES SOUTHEAST OF LINCOLNTON, NORTH CAROLINA

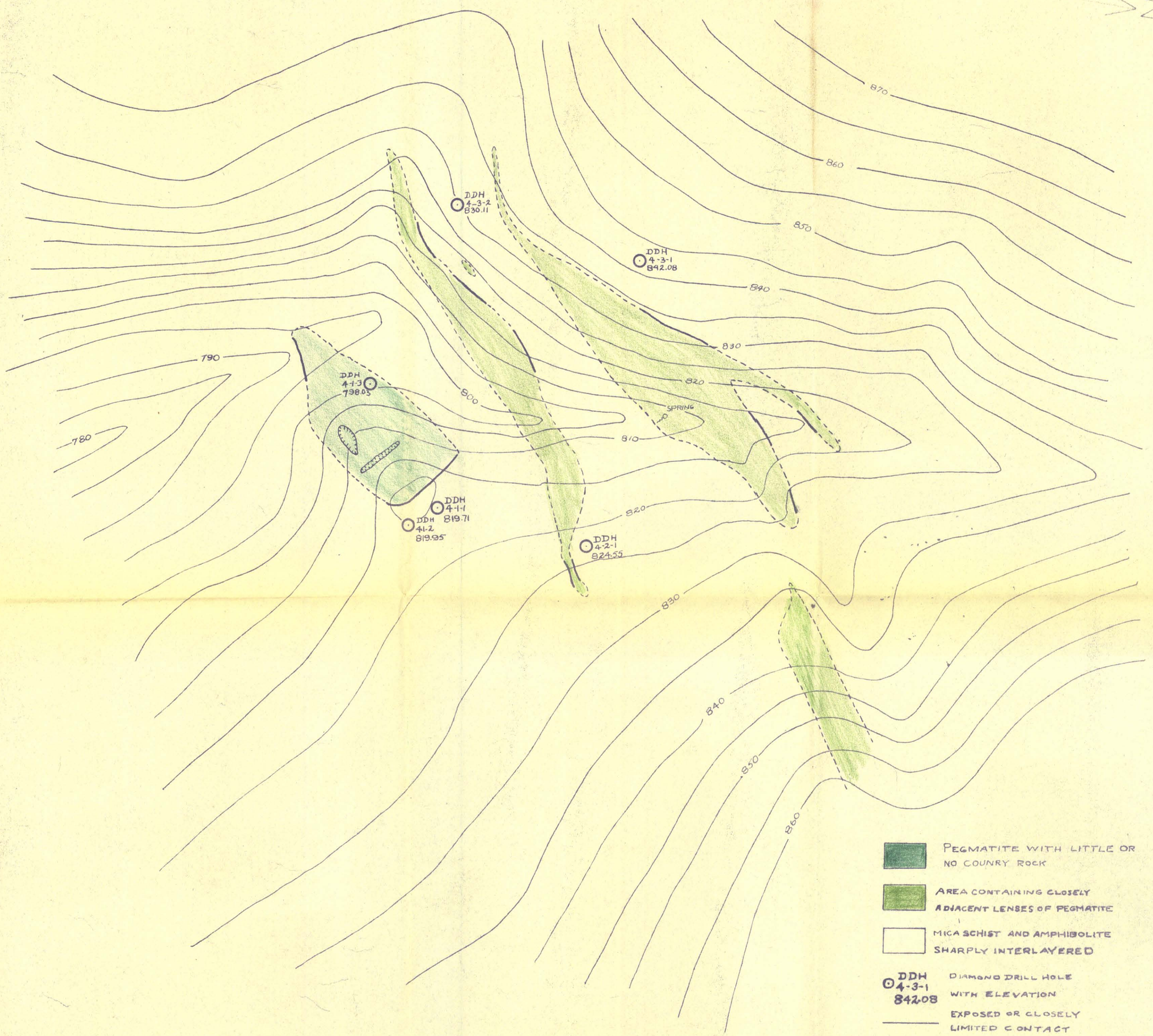


GEOLOGIC MAP OF PART OF THE TIN-SPODUMENE BELT SOUTHWEST OF KINGS MOUNTAIN, NORTH CAROLINA



PLAN OF WORKINGS AND PEGMATITE BODIES EXPOSED ON PROPERTY OF THE KA-MI-TIN CONCENTRATING CO., 2 MILES SOUTHEAST OF LINCOLNTON, NORTH CAROLINA


0 20 50 100 200 300 400 FEET
CONTOUR INTERVAL - 10 FEET
N
DMEA DOCKET 2841
CONTRACT IDM-E523
FINAL REPORT
EXHIBIT
NO. 4
DDH 3-7-1 818
3-7
DDH 3-3-1 892
3-3
3-3-T1
DDH 3-6-1 972
3-6
DDH 3-5-1 842
3-4
DDH 3-4-2 850
DDH 3-5-1 850
DDH 3-5-2 850
3-5
3-5-T1
3-5-T2
3-5-T3
900
ACCESS ROADWAY
DDH 3-2-2 807
3-2-T1
3-2
DDH 3-2-1 690
DDH 3-1-1 821
3-1
3-1-T1
3-1-T2
3-1-T3
900
TO KINGS MOUNTAIN
850
850
800
EXPLORATION AREA IN TRACT 3
SHOWING PEGMATITES EXPLORED
DMEA 2841, IDM-E523, FOOTE MINERAL CO., KINGS MOUNTAIN, N. C.
DDH 3-4-1 (ELEV.) DIAMOND DRILL HOLE WITH ELEVATION
EXPOSED OR CLOSELY LIMITED CONTACT
BOUNDARY OF AREA CONTAINING LENSES OF PEGMATITE RATHER THAN A SOLID BODY.
4-1-54



DMEA DOCKET 2841
CONTRACT IDM-E523
FINAL REPORT
EXHIBIT
NO. 2

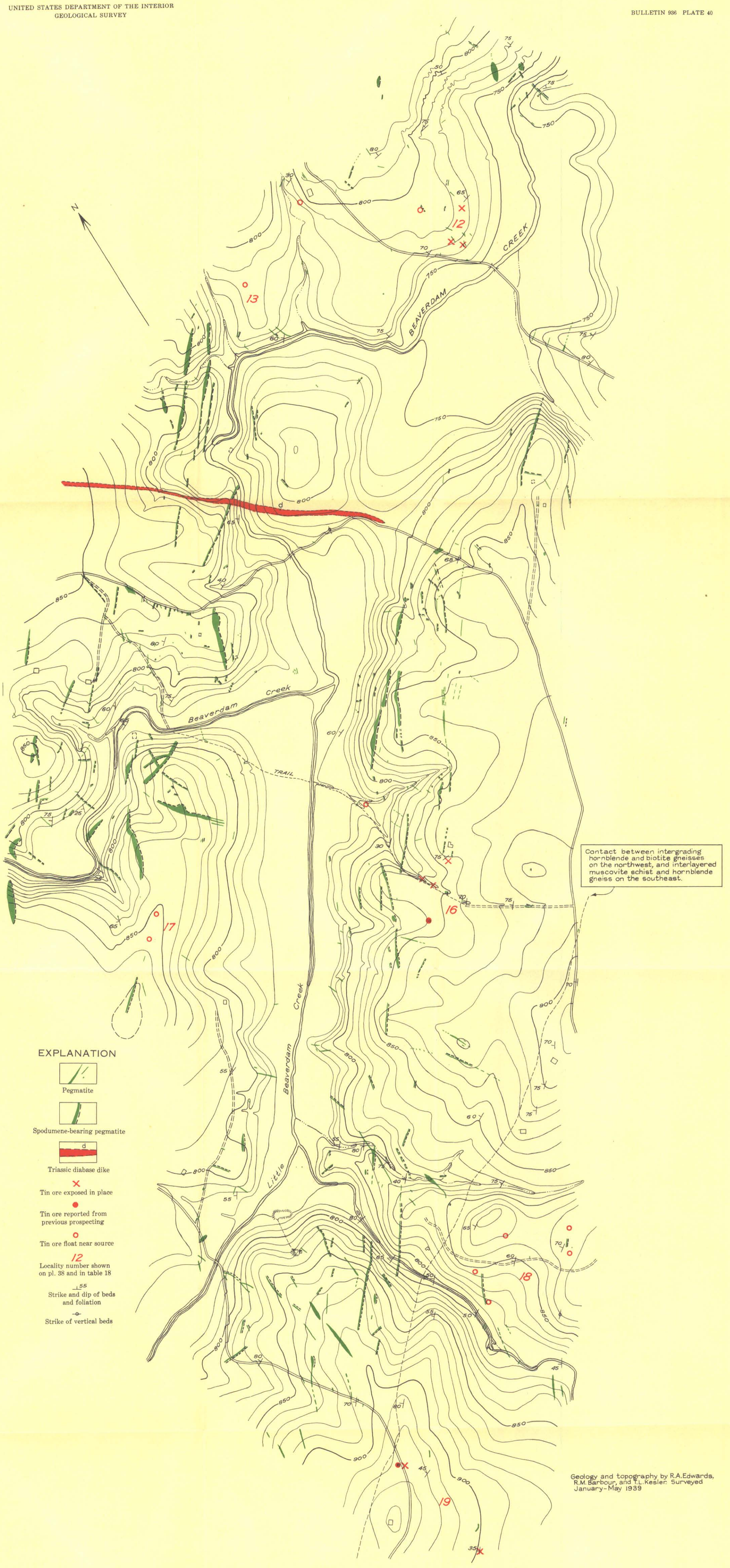
EXPLORATION AREA IN TRACT 4

D.M.E.A. 2841, IDM-E523 FOOTE MINERAL CO.

KINGS MOUNTAIN, N. C.

0 10 50 100 FEET

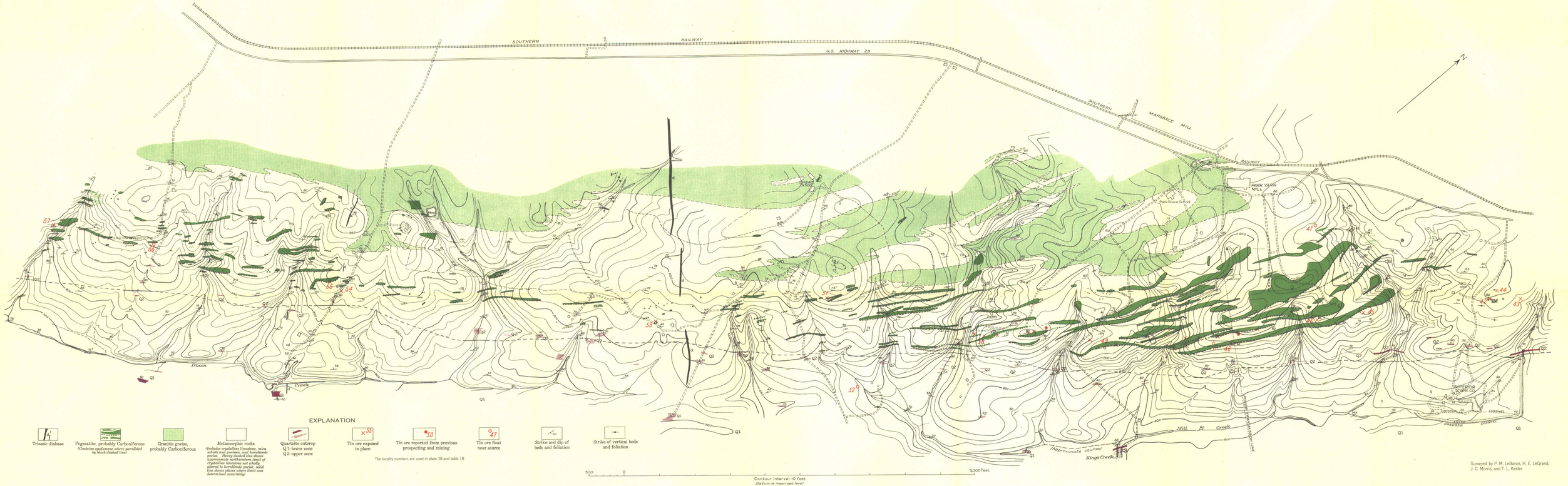
3-29-54



GEOLOGIC MAP OF THE BEAVERDAM CREEK AREA OF THE CAROLINA TIN-SPODUMENE BELT

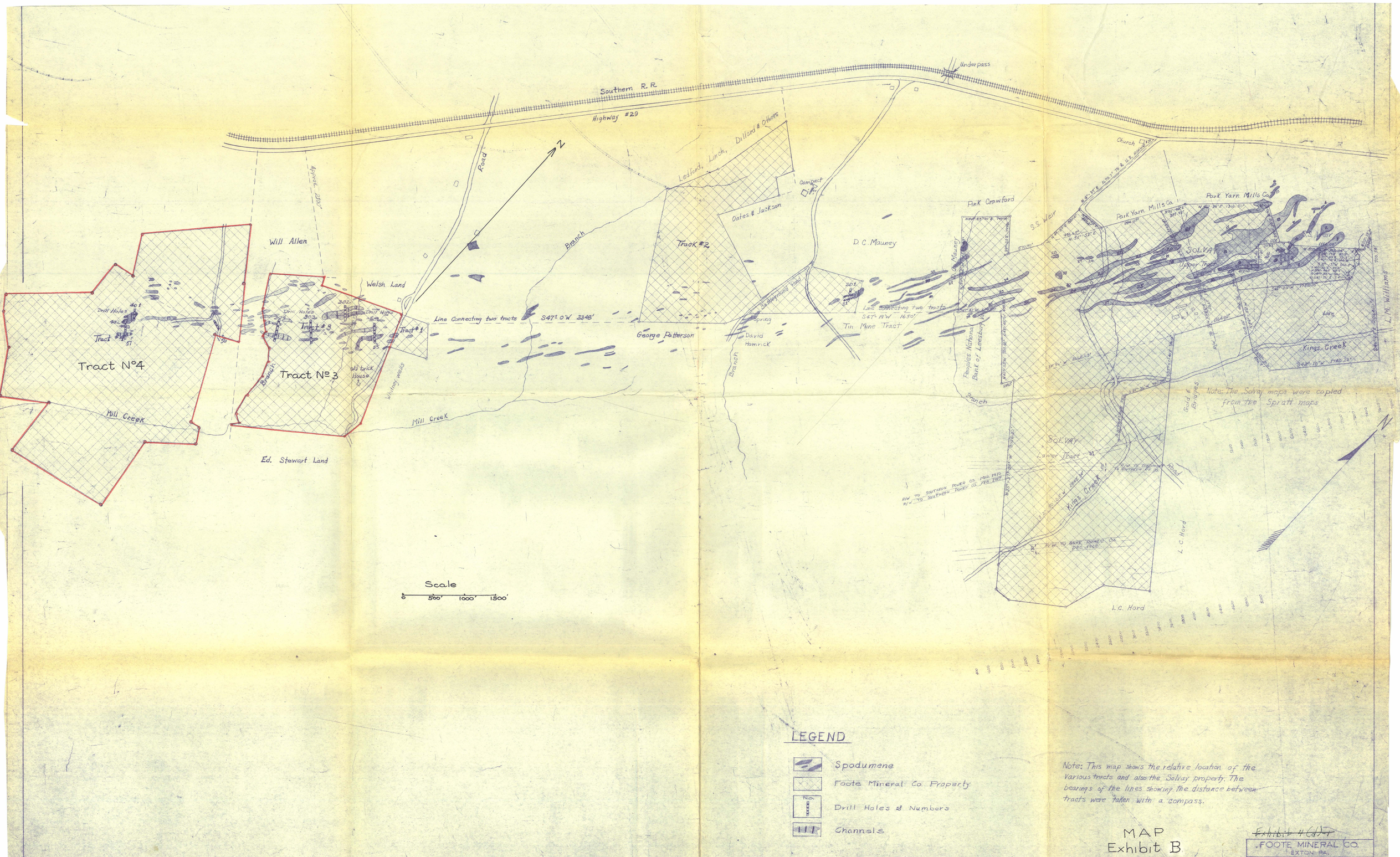
500 0 1,000 Feet

Contour interval 10 feet. *Datum is mean sea level*



Surveyed by P. M. LeBaron, H. E. LeGrand, J. C. Morris, and T. L. Kesler

GEOLOGIC MAP OF PART OF THE TIN-SPODUMENE BELT SOUTHWEST OF KINGS MOUNTAIN, NORTH CAROLINA


Southern R.R.
Highway #29
Underpass
Road
Branch
Ledford, Lynch, Dillard & Others
Compact
Oates & Jackson
Track #2
D.C. Mauney
Pink Crawford
S.S. Weir
Church
Park Yarn Mills Co.
SOLVAY
Upper Tract
Lake
Kings Creek
L.M. Williams
Will Allen
Welsh Land
Tract #1
Tract #3
Tract N°4
Tract N° 3
Drill Holes
Old brick House
Willing Wells
Mill Creek
Ed. Stewart Land
Line Connecting two tracts S47½° O'W 3348'
George Patterson
David Hamrick
Spring
Tin Mine Tract
Line Connecting two tracts S47° 19'W 1650'
Peoples National Bank of Leesburg
Gold & Bryjes
SOLVAY
Lower Tract
Road
L.C. Hord
Scale
0 500' 1000' 1500'
LEGEND
Spodumene
Foote Mineral Co. Property
Drill Holes & Numbers
Channels
Note: The Solvay maps were copied from the Spratt maps
Note: This map shows the relative location of the various tracts and also the Solvay property. The bearings of the lines showing the distance between tracts were taken with a compass.
MAP
Exhibit B
~~Exhibit 4 (d)-7~~
FOOTE MINERAL CO.
EXTON PA.
Scale 1" = 500 ft.
Drawn by: