FILE COPY
SURNAME:

PESONEN

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION
WASHINGTON 25, D. C.

July 16, 1951

Mr. John G. Broughton
State Geologist
New York State Science Service
State Education Building
Albany 1, New York

Subject: DMA-1516X - Application of New York State Science Service for exploration loan of $8,000.

My dear Mr. Broughton:

Your letter of July 6, 1951, to Mr. Franklin G. Pardee, advising that you have decided to withdraw the subject application for exploration loan, is acknowledged.

It is most unfortunate that the terms of the Defense Production Act of 1950 do not cover the conditions set forth in your application.

Very truly yours,

Paul E. Pesonen, Acting Chief
Iron Ores Branch

PEPesonen:md

Copy to: Adm. reading file
Reports & Records Branch
Mr. Lyon
Mr. Pesonen
Files

Mr. Pearson

THE UNIVERSITY OF THE STATE OF NEW YORK
NEW YORK STATE SCIENCE SERVICE
INCLUDING
STATE GEOLOGICAL AND NATURAL HISTORY SURVEYS
STATE EDUCATION BUILDING
ALBANY 1

July 6, 1951

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JUL 9 - 1951
LANDON F. STROBEL
Executive Secretary

Mr. Franklin G. Pardee, Chief
Iron Ores Branch
Defense Minerals Administration
U. S. Department of the Interior
Washington 25, D. C.

Dear Mr. Pardee: Re: DMA-1516X

Thank you for your letter of June 19th outlining the status of the application of the New York State Science Service for an exploration loan of $8,000 (50 percent).

The difficulties which you point out were recognized by us before making the application, and application was made on the basis that your counsel indicated that he saw no reason why a state agency could not cooperate under the program, and because we felt that the primary aim was to locate badly needed sources of strategic minerals. I recognize the fact that your decision cannot be favorable if you are forced to abide by the exact letter of the law, and I am sure you will agree that, as a state agency, it would be pointless for us to reconsider the application in any way.

Sincerely,

John G. Broughton

John G. Broughton
State Geologist

JGB:EW

FILE COPY
SURNAME:

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION
WASHINGTON 25, D. C.

June 20, 1951

Mr. John G. Broughton, State Geologist
State Education Building
Albany 1, New York

Subject: DMA-1516X
Re: Exploration Loan

My dear Mr. Broughton:

Receipt is acknowledged of your application and attachments of May 23, 1951 for an exploration loan under the Defense Production Act of 1950.

The application was assigned Docket Number DMA-1516X and referred to Mr. Franklin Pardee, Chief, Iron Branch on June 7, 1951.

In any future correspondence relating to your application, kindly refer to DMA-1516X.

Sincerely yours,

LANDON F. STROBEL

Landon F. Strobel
Executive Secretary

L. F. Strobel:jc
cc: Strobel
File
Pardee
Lyon

FILE COPY
SURNAME:

Hamilton
Pardee.

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION
WASHINGTON 25, D. C.

June 19, 1951

Mr. John G. Broughton
State Geologist
New York State Science Service
State Education Building
Albany 1, New York

Subject: DMA-1516X - Application of New York State Science Service for exploration loan of $8,000 (50 percent).

Dear Sir:

Referring to the subject application, which has been given careful consideration, we find it necessary to point out the following, which is set forth in Regulation MO-5:

1. The "operator" may be a landowner or a lessee.

2. If a lessee, the landowner must sign a subordination agreement.

3. Repayment:

   (a) If the exploration is successful, the Federal Government may so certify and describe and delimit the discovery.

   (b) The effect of this certification is to obligate the operator and his successor to pay off the Government loan by percentage royalty from the smelter returns or sale of the ore.

   (c) This obligation becomes a lien against the land until the loan is paid, or until 10 years from date of loan contract have elapsed, whichever is first.

We have noted your comment to the effect that neither the State of New York nor any of its official agencies or employees can be obligated to repay the amount of Federal aid by a percentage

royalty on the net proceeds of such development. We understand this applies to both the State and the privately owned land referred to in your application. We would like to point out that the objective which prompted this program to aid exploration was to obtain scarce ores or minerals for the present defense program.

In view of the above, we assume you may wish to reconsider or withdraw your application.

Very truly yours,

Franklin G. Pardee, Chief
Iron Ores Branch

JCHamilton:md

Copy to: Adm. reading file
Mr. Rove, U.S.G.S.
Mr. Moon
Mr. Strobel
Mr. Lyon
Mr. Pardee
Files

a.e.c

June 19, 1951

Mr. John G. Broughton
State Geologist
New York State Science Service
State Education Building
Albany 1, New York

Subject: DMA-1516X - Application of New York State Science Service for exploration loan of $8,000 (50 percent).

Dear Sir:

Referring to the subject application, which has been given careful consideration, we find it necessary to point out the following, which is set forth in Regulation MO-5:

1. The "operator" may be a landowner or a lessee.

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royalty on the net proceeds of such development. We understand this applies to both the State and the privately owned land referred to in your application. We would like to point out that the objective which prompted this program to aid exploration was to obtain scarce ores or minerals for the present defense program.

In view of the above, we assume you may wish to reconsider or withdraw your application.

Very truly yours,

Franklin C. Fardee, Chief
Iron Ores Branch

JCHamilton:md

Copy to: Adm. reading file
Mr. Rove, U.S.G.S.
Mr. Moon
Mr. Strobel
Mr. Lyon
Mr. Fardee
Files

a. E. P.

June 12, 1951

Memorandum

To: Tom Lyon, Director, Supply Division

From: Franklin G. Pardee, Chief, Iron Ores Branch

Subject: Applications for exploration loans from Department of Commerce, State of New York - DMA-1453X, $3,500 and DMA-1516X, $8,000.

The applications listed above have been referred to the Iron Ores Branch for necessary action.

Two questions arise: first, is it legal under the Defense Act and DMA MO-5; second, is it the policy of the Department to approve such loans.

Mr. J. L. Hefflund, General Counsel of the DMA, has already given a written opinion of the legal aspects in a letter dated April 18, 1951, to R. B. Peterson, Acting Director, Bureau of Business Promotion, New York State Department of Commerce. His conclusions are quoted in Mr. Broughton's letter of May 22, 1951, and are as follows:

> "There is no reason, so far as the United States is concerned, why a state acting through its authorized agencies could not receive aid under the Mineral Exploration program."

It is our idea that the prime requisite of the exploration program is to discover the important strategic and critical minerals, which in this case is iron ore. The next step, in the event of discovery, is the exploitation of the deposit to supply these materials for the defense needs and, at the same time, provide for the repayment of the loan through royalties on the ore extracted.

It is very probable that if these loans are granted we will find ourselves in the midst of a scramble by the states for Federal money to explore their natural mineral resources without any obligation on their part to develop the resources for the benefit of the national emergency. In this connection, we quote from the letter of New York State Geologist J. G. Broughton, dated May 22, 1951:

"If deposits of magnetite are found and developed as a result of this magnetic exploration, it is obvious that neither the State of New York or any of its official agencies or employees can be obligated to repay the amount of Federal aid by a percentage royalty on the net proceeds of such development."

Before processing the two loans referred to above, we would appreciate an expression of opinion of the policy to be adopted for such loans.

F. G. Pardee, Chief
Iron Ores Branch

FGPardee:md

Copy to: Adm. reading file
Mr. Feiss
Mr. Strobel
Mr. Pardee
Files

dma 1516 X

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

COLLEGE PARK, MARYLAND

Send to Pardie

May 28, 1951

Memorandum

To: Tom Lyon, Chairman, Coordinating Committee, DMA

From: Executive Officer, Bureau-Survey Field Team, Region VIII

Transmitted herewith for your consideration is an application for aid for an exploration project submitted by the New York State Science Service, through John G. Broughton, State Geologist.

McHenry Mosier

McHenry Mosier

Attachments

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JUN 1 - 1951
LANDON F. STROBEL
Executive Secretary

dma 1516 X

THE UNIVERSITY OF THE STATE OF NEW YORK
NEW YORK STATE SCIENCE SERVICE
INCLUDING
STATE GEOLOGICAL AND NATURAL HISTORY SURVEYS
STATE EDUCATION BUILDING
ALBANY 1

May 23, 1951

Executive Officer
Defense Minerals Administration
Eastern Experiment Station
College Park, Maryland

Dear Sir:

You will find attached herewith an application for aid for an exploration project pursuant to Mineral Order 5, under the Defense Production Act of 1950. Inasmuch as the applicant is an official agency of the State of New York and not a private individual, partnership or corporation, many questions in form MF-103 are not applicable. For that reason, the following letter of explanation is somewhat expanded.

The New York State Science Service is applying for aid on an exploration project for iron ore which will cost $8000. It is understood that the Federal Government will contribute 50% of this sum, if the project is approved. Application is made in the light of a letter dated April 18, 1951 from J. L. Hofflund, General Counsel of the D.M.A. to Ronald B. Peterson, Acting Director, Bureau of Business Promotion, New York State Department of Commerce, in which Mr. Hofflund says in part, "There is no reason, so far as the United States is concerned, why a state acting through its authorized agencies could not receive aid under the Mineral Exploration Program."

As outlined on form MF-103 (attached), the project involves the carrying on of dip needle and dial compass surveys of certain areas in the McKeever and Loon Lake, N. Y. Quadrangles in which magnetic anomalies have been indicated as a result of aeromagnetic work carried on by the U.S. Geological Survey. The New York State Science Service began such surveys in 1946 and has carried them on since that year. Results of such a survey in the Russell, N.Y. Quadrangle are summarized in N.Y.S. Science Service Report of Investigation No. 2, herewith attached.

This project is already set up for further work during 1951 by the New York State Science Service. Additional Federal funds will simply aid in more rapid completion of the work. Actual location of the magnetic anomalies to be surveyed can be given at a later time if clearance for such use of the maps is given by the U.S. Geological Survey. In general, the anomalies are concentrated in the northeastern 1/4 of the McKeever Quadrangle and the northern 1/3 of the Loon Lake Quadrangle. Surveys are made wherever necessary, including both private and state lands.

Field work will be carried on by two four-men field parties which will be based in the field as close to the centers of activity as possible. Scientific equipment, transportation, tents, cots and other necessary equipment and supplies will be supplied by the State Science Service.

The New York State Science Service carries on fundamental scientific research which is of aid to other agencies and people of New York State and derives no profit from the development of mineral deposits. If, therefore, deposits of magnetite are found and developed as a result of this magnetic exploration, it is obvious that neither the State of New York or any of its official agencies or employees can be obligated to repay the amount of Federal aid by a percentage royalty on the net proceeds of such development as required by Section 14 of MO-5.

It is further understood that the exploration project will be under the direction of the New York State Science Service so that it can be integrated with its continuing program.

Additional supporting data and explanations can be supplied by the undersigned either by correspondence or by personal interview in Albany, New York or Washington, D. C.

Very sincerely yours,

John G. Broughton

John G. Broughton
State Geologist

JGB:fjh

Form MF-113
(April 1951)

U. DEPARTMENT OF THE INTERI

DEFENSE MINERALS ADMINISTRATION

Budget Bureau No. 42-R1035.
Approval expires 6-30-51.

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

DO NOT FILL IN THIS BLOCK

Docket No. dma 1516X

Date received 6-1-51

Participation

Name and address of applicant

Date

FILL IN THIS BLOCK

Date of application May 22, 1951

Estimated cost $8000

Mineral or metal Iron ore

Percentage of Government participation 50%

Location of mine McKeever and Loon Lake quadrangles, New York

Date of filing MF-100

DMA Docket Number, if available

INSTRUCTIONS

Read Mineral Order 5, Regulations Governing Government Aid in Defense Projects, before completing this application. Submit four signed copies of the application to Defense Minerals Administration, Department of the Interior, Washington 25, D. C., or to the nearest field executive officer thereof, with your name and address on each sheet of the application and all accompanying papers. If any question is inapplicable, or if you cannot answer it, so state on the form. Where the space provided for answer is insufficient, answer on a separate sheet, annex it to the application form, and refer to it in space for answer. If the application is approved, you will be presented with an exploration project contract on Form MF-200, for your signature.

THE APPLICANT

*1. Is applicant an individual, partnership, or corporation? See letter attached.

*2. If a partnership, state names and addresses of partners. " " "

*3. If a corporation, state names and addresses of officers, directors, and five largest stockholders. See letter attached.

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

*5. Are you the owner or the lessee of the property? See letter attached.

6. If owner, state what claims, liens, or encumbrances, if any, are against the property. See letter attached.

7. If lessee, attach a copy of the lease and state if it is in good standing. See letter attached.

NOTE.—It will be necessary to procure and attach to the exploration project contract agreements of claimants, lienors, encumbrances and lessors subordinating their interests in the property to the interest of the Government under the contract.

8. Furnish current financial statement, showing assets and liabilities, and a profit and loss statement. See letter attached

9. How much money is applicant prepared to invest in proposed project? Is it sufficient to pay your part of the cost of the project as detailed in question 23 of this application form, in accordance with the regulations on Government participation (Section 9 of Mineral Order 5)?

*If you have already answered these questions on MF-100, you are not required to answer the questions for this application.

16—64067-1

THE PROPERTY

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

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

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

*11. State the present and former names of the property, if any. See letter attached

*12. State, in detail, the location of the property with reference to towns, railroads, roads, shipping points, including distances and directions and kinds and conditions of roads. See letter attached.

*13. State source and quantity of water available for operations and its sufficiency at all seasons. Not applicable. State amount of power to be used, rate per hour or other cost, and source.

*14. Describe any existing useable facilities, equipment, buildings, or structure now on the property that will be devoted to the exploration work. Not applicable.

15. State in detail how the ore could be shipped and how and where milled. Not applicable.

*16. History:

(*a*) Give a statement, as complete as possible, of previous exploration, development, operation, and production of property, with reasons for any past suspensions of operations.

(*b*) State briefly the known history and production of adjoining and neighboring properties.

(*c*) Furnish any available (private) reports that may apply to this application, including results of mine examinations, recommended exploration and development, and metallurgical investigations.

*17. Production:

(*a*) If mine is in production, furnish the following information: Not applicable.

	Tons per day	*Grade or analysis*	*Cost per ton*	*Net value per ton*
(1) Mining				
(2) Milling				
(3) Shipped or sold				

*18. Ore or mineral reserves: (If property is or has been operating.) Not applicable.

(*a*) Describe the ore or mineral deposits briefly.

(*b*) Submit available maps and assay data.

(*c*) Give estimated tonnage and grade of each class of ore reserves.

19. State any conditions or circumstances regarding the property not sufficiently brought out by the foregoing questions.
See letter attached.

THE EXPLORATION

20. For what mineral or minerals and for what types of deposits and ores will the exploration be conducted?

21. Describe briefly, but concisely, the proposed work and the estimated time required to complete it.

NOTE.—The Government will not participate in a project that will require more than 2 years to complete.

22. Furnish statement of the geological basis of the project with particular emphasis on factors leading the operator to expect the finding of commercial ore bodies. This statement should be accompanied by supporting maps such as geological maps, maps of the proposed openings and assay maps, sample lists, and other pertinent data.

THE REQUIREMENTS AND COSTS

23. Tabulate in the form of an itemized statement with a sum for each item the estimated requirements and costs of the project so that the total will give the estimated cost of the project in which the Government will participate, as follows:

(*a*) Labor, by numbers and classes (miners, muckers, millmen, etc.), with wages of each.

(*b*) Supervisors, by numbers and positions, with salaries of each.

(*c*) Cost of necessary repairs to existing facilities, structures, and buildings.

(*d*) Cost of necessary installation or construction of additional facilities, structures, and buildings.

(*e*) Cost of items of equipment, not now owned by the applicant which must be purchased for operations at a cost of $50 or more each.

(*f*) Cost of rental for equipment which the operator proposes to rent.

(*g*) Rental value of items of equipment which the operator now owns and which will be devoted to the work.

(*h*) Cost of materials and supplies, including items of equipment costing less than $50 each.

(*i*) Cost of power, water, utilities, and any other items not provided for above.

24. Furnish a time schedule of the project, stated in terms of months after project is approved, showing progress expected to be accomplished and the money expected to be spent.

CERTIFICATION

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

New York State Science Service
(Name of ~~company~~) state governmental agency.

By John G. Broughton
(Signature of authorized official)

May 24, 1951
(Date)

State Geologist
(Title)

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

*Same as footnote on page 1.

16—64067-1 U. S. GOVERNMENT PRINTING OFFICE

4. The field work will be carried on under the general direction of John G. Broughton, State Geologist, and the specific direction of Benjamin M. Shaub, Temporary Geologist of the New York State Science Service, both of whom have directed identical work in New York State during the period 1946 - 1950. Broughton has done progressively responsible work in economic geology since 1936 and Shaub has been employed as mining engineer and geologist since 1929.

9. $4000 ~~+~~ scientific instruments and field equipment already in applicant's possession.

10. McKeever Quadrangle Lat. 43°30'-43°45'N Long. 75°00'-75°15'W

Loon Lake " Lat. 44°30'-44°45'N Long. 74°00'-74°15'W

16. (a) There has been no recorded production from any iron ore deposits in the Loon Lake Quadrangle. (b) Closest current production is from the "81" and "Chateaugay" mines, operated by the Republic Steel Corporation which are respectively 2½ and 5 miles east of the Loon Lake Quadrangle. Production from these mines had a value in 1949 of approximately $3,000,000. The Chateaugay mine has been operated practically continuously since 1868. The history of these mines are detailed in the article by J. R. Linney "A century and a half of development behind the Adirondack iron mining industry" on pages 480-487, of the Nov. 1943 issue of Mining & Metallurgy, herewith attached. (a) No production has been reported within the McKeever Quadrangle.

20. Exploration will be conducted for lenses and "veins" of magnetite (magnetic iron ore).

21. Systematic dip needle and dial compass surveys will be made in the Loon Lake Quadrangle and that portion of the McKeever Quadrangle not already completed by the N. Y. State Science Service field parties during the 1950 field season. The exact location of the surveys will be determined by the location of magnetic anomalies already located by aeromagnetic work. Unpublished maps indicating these localities have been supplied by the U.S. Geological Survey. Base lines are laid out along the trend of the assumed anomaly and side traverses are laid out at right angles to it. Magnetic readings are taken every 50 - 200 ft. feet along the base line and traverses and after plotting are contoured to delineate the anomaly.

It is believed that two four-man field parties could complete the McKeever Quadrangle and a large part of the Loon Lake Quadrangle in 2½ months time. If not completed during the summer of 1951, could be completed during 1952 field season.

22. Previous geological and geophysical field work in the Adirondacks has indicated that where a magnetic disturbance is present, it is, with minor exceptions, prima facie evidence of the presence of magnetic iron ore. This may be exposed at the surface or buried beneath deposits of sand, gravel or mud. Aeromagnetic surveys flown at a constant elevation tend to emphasize anomalies on mountain tops and minimize those in valleys or under a great thickness of alluvial or glacial cover. For that reason, a ground survey gives greater detail and accuracy and is absolutely necessary before testing by core-drilling can be carried on.

The rocks in which the anomalies of the McKeever and Loon Lake Quadrangles occur are similar to those which contain commercial deposits of magnetite elsewhere in the Adirondacks and must therefore be considered worthy of investigation until proved otherwise.

23.

a. 2 party leaders	$1075 00
6 field assistants	2650 00
2 cooks	650 00
b. Temporary geologist (in charge)	1175 00
	5550 00

c. No charge.

d. No charge.

e. No charge.

f. No charge.

g. Dip needles, dial compasses, motor vehicles, living accomodations - No charge.

h. Cost of materials and supplies	200 00
i. Traveling expense, automotive expense, fuel, light, power, water and food (while in field)	2250 00

24. It is expected that the work outlined above can be finished in 2½ months of working time and certainly before the end of the 1952 field season. Additional work will be carried on with non-cooperative N.Y. State Science Service funds.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JUN 1 - 1951
LANDON F. STROBEL
Executive Secretary

1951 MAY 28 PM 1:32
BUREAU OF MINES
COLLEGE PARK, MD.

dmm 1516X

THE UNIVERSITY OF THE STATE OF NEW YORK
NEW YORK STATE SCIENCE SERVICE
INCLUDING
STATE GEOLOGICAL AND NATURAL HISTORY SURVEYS
STATE EDUCATION BUILDING
ALBANY 1

May 22, 1951

Executive Officer
Defense Minerals Administration
Eastern Experiment Station
College Park, Maryland

Dear Sir:

You will find attached herewith an application for aid for an exploration project pursuant to Mineral Order 5, under the Defense Production Act of 1950. Inasmuch as the applicant is an official agency of the State of New York and not a private individual, partnership or corporation, many questions in form MF-103 are not applicable. For that reason, the following letter of explanation is somewhat expanded.

The New York State Science Service is applying for aid on an exploration project for iron ore which will cost $8000. It is understood that the Federal Government will contribute 50% of this sum, if the project is approved. Application is made in the light of a letter dated April 18, 1951 from J. L. Hefflund, General Counsel of the D.M.A. to Ronald B. Peterson, Acting Director, Bureau of Business Promotion, New York State Department of Commerce, in which Mr. Hefflund says in part, "There is no reason, so far as the United States is concerned, why a state acting through its authorized agencies could not receive aid under the Mineral Exploration Program."

As outlined on form MF-103 (attached), the project involves the carrying on of dip needle and dial compass surveys of certain areas in the McKeever and Loon Lake, N. Y. Quadrangles in which magnetic anomalies have been indicated as a result of aeromagnetic work carried on by the U.S. Geological Survey. The New York State Science Service began such surveys in 1946 and has carried them on since that year. Results of such a survey in the Russell, N. Y. Quadrangle are summarized in N.Y.S. Science Service Report of Investigation No. 2, herewith attached.

This project is already set up for further work during 1951 by the New York State Science Service. Additional Federal funds will simply aid in more rapid completion of the work. Actual location of the magnetic anomalies to be surveyed can be given at a later time if clearance for such use of the maps is given by the U.S. Geological Survey. In general, the anomalies are concentrated in the northeastern 1/4 of the McKeever Quadrangle and the northern 1/3 of the Loon Lake Quadrangle. Surveys are made wherever necessary, including both private and state lands.

Field work will be carried on by two four-man field parties which will be based in the field as close to the centers of activity as possible. Scientific equipment, transportation, tents, cots and other necessary equipment and supplies will be supplied by the State Science Service.

If deposits of magnetite are found and developed as a result of this magnetic exploration, it is obvious that neither the State of New York or any of its official agencies or employees can be obligated to repay the amount of Federal aid by a percentage royalty on the net proceeds of such development.

It is further understood that the exploration project will be under the direction of the New York State Science Service so that it can be integrated with its continuing program.

Additional supporting data and explanations can be supplied by the undersigned either by correspondence or by personal interview in Albany, New York or Washington, D. C.

Very sincerely yours,

John G. Broughton

John G. Broughton
State Geologist

JGB:fjh

Form MF-103
(April 1951)

U. DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION

Budget Bureau No. 42-R1035.
Approval expires 6-30-51.

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

DO NOT FILL IN THIS BLOCK

Docket No. dma 1516 X

Date received 6-1-51

Participation

Name and address of applicant

Date

FILL IN THIS BLOCK

Date of application May 22, 1951

Estimated cost $8000

Mineral or metal Iron ore

Percentage of Government participation 50%

Location of mine McKeever and Loon Lake quadrangles, New York

Date of filing MF-100

DMA Docket Number, if available

INSTRUCTIONS

Read Mineral Order 5, Regulations Governing Government Aid in Defense Projects, before completing this application. Submit four signed copies of the application to Defense Minerals Administration, Department of the Interior, Washington 25, D. C., or to the nearest field executive officer thereof, with your name and address on each sheet of the application and all accompanying papers. If any question is inapplicable, or if you cannot answer it, so state on the form. Where the space provided for answer is insufficient, answer on a separate sheet, annex it to the application form, and refer to it in space for answer. If the application is approved, you will be presented with an exploration project contract on Form MF-200, for your signature.

THE APPLICANT

*1. Is applicant an individual, partnership, or corporation? See letter attached.

*2. If a partnership, state names and addresses of partners. " " "

*3. If a corporation, state names and addresses of officers, directors, and five largest stockholders. See letter attached.

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

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6. If owner, state what claims, liens, or encumbrances, if any, are against the property. See letter attached.

7. If lessee, attach a copy of the lease and state if it is in good standing. See letter attached.

NOTE.—It will be necessary to procure and attach to the exploration project contract agreements of claimants, lienors, encumbrances and lessors subordinating their interests in the property to the interest of the Government under the contract.

8. Furnish current financial statement, showing assets and liabilities, and a profit and loss statement. See letter attach

9. How much money is applicant prepared to invest in proposed project? Is it sufficient to pay your part of the cost of the project as detailed in question 23 of this application form, in accordance with the regulations on Government participation (Section 9 of Mineral Order 5)?

*If you have already answered these questions on MF-100, you are not required to answer the questions for this application.

16—64067-1

THE PROPERTY

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

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

*11. State the present and former names of the property, if any. See letter attached.

*12. State, in detail, the location of the property with reference to towns, railroads, roads, shipping points, including distances and directions and kinds and conditions of roads. See letter attached.

*13. State source and quantity of water available for operations and its sufficiency at all seasons. Not applicable.
State amount of power to be used, rate per hour or other cost, and source.

*14. Describe any existing useable facilities, equipment, buildings, or structure now on the property that will be devoted to the exploration work. Not applicable.

15. State in detail how the ore could be shipped and how and where milled. Not applicable.

*16. History:

(*a*) Give a statement, as complete as possible, of previous exploration, development, operation, and production of property, with reasons for any past suspensions of operations.

(*b*) State briefly the known history and production of adjoining and neighboring properties.

(*c*) Furnish any available (private) reports that may apply to this application, including results of mine examinations, recommended exploration and development, and metallurgical investigations.

*17. Production:

(*a*) If mine is in production, furnish the following information: Not applicable.

	Tons per day	*Grade or analysis*	*Cost per ton*	*Net value per ton*
(1) Mining				
(2) Milling				
(3) Shipped or sold				

*18. Ore or mineral reserves: (If property is or has been operating.)

(*a*) Describe the ore or mineral deposits briefly.

(*b*) Submit available maps and assay data.

(*c*) Give estimated tonnage and grade of each class of ore reserves.

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

See letter attached.

THE EXPLORATION

20. For what mineral or minerals and for what types of deposits and ores will the exploration be conducted?

21. Describe briefly, but concisely, the proposed work and the estimated time required to complete it.

NOTE.—The Government will not participate in a project that will require more than 2 years to complete.

22. Furnish statement of the geological basis of the project with particular emphasis on factors leading the operator to expect the finding of commercial ore bodies. This statement should be accompanied by supporting maps such as geological maps, maps of the proposed openings and assay maps, sample lists, and other pertinent data.

THE REQUIREMENTS AND COSTS

23. Tabulate in the form of an itemized statement with a sum for each item the estimated requirements and costs of the project so that the total will give the estimated cost of the project in which the Government will participate, as follows:

(*a*) Labor, by numbers and classes (miners, muckers, millmen, etc.), with wages of each.

(*b*) Supervisors, by numbers and positions, with salaries of each.

(*c*) Cost of necessary repairs to existing facilities, structures, and buildings.

(*d*) Cost of necessary installation or construction of additional facilities, structures, and buildings.

(*e*) Cost of items of equipment, not now owned by the applicant which must be purchased for operations at a cost of $50 or more each.

(*f*) Cost of rental for equipment which the operator proposes to rent.

(*g*) Rental value of items of equipment which the operator now owns and which will be devoted to the work.

(*h*) Cost of materials and supplies, including items of equipment costing less than $50 each.

(*i*) Cost of power, water, utilities, and any other items not provided for above.

24. Furnish a time schedule of the project, stated in terms of months after project is approved, showing progress expected to be accomplished and the money expected to be spent.

CERTIFICATION

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

New York State Science Service — By John G. Broughton
(Name of ~~company~~) State governmental agency — (Signature of authorized official)

May 24, 1951 — State Geologist
(Date) — (Title)

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

*Same as footnote on page 1.

16—04067-1 U. S. GOVERNMENT PRINTING OFFICE

4. The field work will be carried on under the general direction of John G. Broughton, State Geologist, and the specific direction of Benjamin H. Shaub, Temporary Geologist of the New York State Science Service, both of whom have directed identical work in New York State during the period 1946 - 1950. Broughton has done progressively responsible work in economic geology since 1936 and Shaub has been employed as mining engineer and geologist since 1929.

9. $4000 ± scientific instruments and field equipment already in applicant's possession.

10. McKeever Quadrangle Lat. 43°30'-43°45'N Long. 75°00'-75°15'W

Loon Lake " Lat. 44°30'-44°45'N Long. 74°00'-74°15'W

16. (a) There has been no recorded production from any iron ore deposits in the Loon Lake Quadrangle. (b) Closest current production is from the "81" and "Chateaugay" mines, operated by the Republic Steel Corporation which are respectively 2½ and 5 miles east of the Loon Lake Quadrangle. Production from these mines had a value in 1949 of approximately $3,000,000. The Chateaugay mine has been operated practically continuously since 1868. The history of these mines are detailed in the article by J. R. Linney "A century and a half of development behind the Adirondack iron mining industry" on pages 480-487, of the Nov. 1943 issue of Mining & Metallurgy, herewith attached. (a) No production has been reported within the McKeever Quadrangle.

20. Exploration will be conducted for lenses and "veins" of magnetite (magnetic iron ore).

21. Systematic dip needle and dial compass surveys will be made in the Loon Lake Quadrangle and that portion of the McKeever Quadrangle not already completed by the N. Y. State Science Service field parties during the 1950 field season. The exact location of the surveys will be determined by the location of magnetic anomalies already located by aeromagnetic work. Unpublished maps indicating these localities have been supplied by the U.S. Geological Survey. Base lines are laid out along the trend of the assumed anomaly and side traverses are laid out at right angles to it. Magnetic readings are taken every 50 - 200 ft. feet along the base line and traverses and after plotting are contoured to delineate the anomaly.

It is believed that two four-man field parties could complete the McKeever Quadrangle and a large part of the Loon Lake Quadrangle in 2½ months time. If not completed during the summer of 1951, could be completed during 1952 field season.

22. Previous geological and geophysical field work in the Adirondacks has indicated that where a magnetic disturbance is present, it is, with minor exceptions, prima facie evidence of the presence of magnetic iron ore. This may be exposed at the surface or buried beneath deposits of sand, gravel or mud. Aeromagnetic surveys flown at a constant elevation tend to emphasize anomalies on mountain tops and minimize those in valleys or under a great thickness of alluvial or glacial cover. For that reason, a ground survey gives greater detail and accuracy and is absolutely necessary before testing by core-drilling can be carried on.

The rocks in which the anomalies of the McKeever and Loon Lake Quadrangles occur are similar to those which contain commercial deposits of magnetite elsewhere in the Adirondacks and must therefore be considered worthy of investigation until proved otherwise.

23.

a. 2 party leaders	$1075 00
6 field assistants	2650 00
2 cooks	650 00
b. Temporary geologist (in charge)	1175 00
	5550 00

c. No charge.

d. No charge.

e. No charge.

f. No charge.

g. Dip needles, dial compasses, motor vehicles, living accomodations - No charge.

h. Cost of materials and supplies	200 00
i. Traveling expense, automotive expense, fuel, light, power, water and food (while in field)	2250 00

24. It is expected that the work outlined above can be finished in 2½ months of working time and certainly before the end of the 1952 field season. Additional work will be carried on with non-cooperative N.Y. State Science Service funds.

BUREAU OF MINES
COLLEGE PARK, MD.

1951 MAY 28 PM 1 : 32

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JUN 1 - 1951
LAMDON F. STROBEL
Executive Secretary

Dma 1516 X

THE UNIVERSITY OF THE STATE OF NEW YORK
NEW YORK STATE SCIENCE SERVICE
INCLUDING
STATE GEOLOGICAL AND NATURAL HISTORY SURVEYS
STATE EDUCATION BUILDING
ALBANY 1

May 22, 1951

Executive Officer
Defense Minerals Administration
Eastern Experiment Station
College Park, Maryland

Dear Sir:

You will find attached herewith an application for aid for an exploration project pursuant to Mineral Order 5, under the Defense Production Act of 1950. Inasmuch as the applicant is an official agency of the State of New York and not a private individual, partnership or corporation, many questions in form MF-103 are not applicable. For that reason, the following letter of explanation is somewhat expanded.

The New York State Science Service is applying for aid on an exploration project for iron ore which will cost $8000. It is understood that the Federal Government will contribute 50% of this sum, if the project is approved. Application is made in the light of a letter dated April 18, 1951 from J. L. Hofflund, General Counsel of the D.M.A. to Ronald B. Peterson, Acting Director, Bureau of Business Promotion, New York State Department of Commerce, in which Mr. Hofflund says in part, "There is no reason, so far as the United States is concerned, why a state acting through its authorized agencies could not receive aid under the Mineral Exploration Program."

As outlined on form MF-103 (attached), the project involves the carrying on of dip needle and dial compass surveys of certain areas in the McKeever and Loon Lake, N. Y. Quadrangles in which magnetic anomalies have been indicated as a result of aeromagnetic work carried on by the U.S. Geological Survey. The New York State Science Service began such surveys in 1946 and has carried them on since that year. Results of such a survey in the Russell, N. Y. Quadrangle are summarized in N.Y.S. Science Service Report of Investigation No. 2, herewith attached.

This project is already set up for further work during 1951 by the New York State Science Service. Additional Federal funds will simply aid in more rapid completion of the work. Actual location of the magnetic anomalies to be surveyed can be given at a later time if clearance for such use of the maps is given by the U.S. Geological Survey. In general, the anomalies are concentrated in the northeastern 1/4 of the McKeever Quadrangle and the northern 1/3 of the Loon Lake Quadrangle. Surveys are made wherever necessary, including both private and state lands.

Field work will be carried on by two four-man field parties which will be based in the field as close to the centers of activity as possible. Scientific equipment, transportation, tents, cots and other necessary equipment and supplies will be supplied by the State Science Service.

If deposits of magnetite are found and developed as a result of this magnetic exploration, it is obvious that neither the State of New York or any of its official agencies or employees can be obligated to repay the amount of Federal aid by a percentage royalty on the net proceeds of such development.

It is further understood that the exploration project will be under the direction of the New York State Science Service so that it can be integrated with its continuing program.

Additional supporting data and explanations can be supplied by the undersigned either by correspondence or by personal interview in Albany, New York or Washington, D. C.

Very sincerely yours,

John G. Broughton

John G. Broughton
State Geologist

JGB:fjh

Form MF-103
(April 1951)

U. DEPARTMENT OF THE INTER

DEFENSE MINERALS ADMINISTRATION

Budget Bureau No. 42-R1035.
Approval expires 6-30-51.

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

DO NOT FILL IN THIS BLOCK

Docket No. DMA 1516X

Date received 6-1-51

Participation

Name and address of applicant

Date

FILL IN THIS BLOCK

Date of application May 22, 1951

Estimated cost $3000

Mineral or metal Iron ore

Percentage of Government participation 50%

Location of mine McKeever and Loon Lake quadrangles, New York

Date of filing MF-100

DMA Docket Number, if available

INSTRUCTIONS

Read Mineral Order 5, Regulations Governing Government Aid in Defense Projects, before completing this application. Submit four signed copies of the application to Defense Minerals Administration, Department of the Interior, Washington 25, D. C., or to the nearest field executive officer thereof, with your name and address on each sheet of the application and all accompanying papers. If any question is inapplicable, or if you cannot answer it, so state on the form. Where the space provided for answer is insufficient, answer on a separate sheet, annex it to the application form, and refer to it in space for answer. If the application is approved, you will be presented with an exploration project contract on Form MF-200, for your signature.

THE APPLICANT

*1. Is applicant an individual, partnership, or corporation? See letter attached.

*2. If a partnership, state names and addresses of partners. " " "

*3. If a corporation, state names and addresses of officers, directors, and five largest stockholders. See letter attached.

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

*5. Are you the owner or the lessee of the property? See letter attached.

6. If owner, state what claims, liens, or encumbrances, if any, are against the property. See letter attached.

7. If lessee, attach a copy of the lease and state if it is in good standing.

NOTE.—It will be necessary to procure and attach to the exploration project contract agreements of claimants, lienors, encumbrances and lessors subordinating their interests in the property to the interest of the Government under the contract. See letter attach

8. Furnish current financial statement, showing assets and liabilities, and a profit and loss statement.

9. How much money is applicant prepared to invest in proposed project? Is it sufficient to pay your part of the cost of the project as detailed in question 23 of this application form, in accordance with the regulations on Government participation (Section 9 of Mineral Order 5)?

*If you have already answered these questions on MF-100, you are not required to answer the questions for this application.

16—64067-1

THE PROPERTY

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

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

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

*11. State the present and former names of the property, if any. See letter attached.

*12. State, in detail, the location of the property with reference to towns, railroads, roads, shipping points, including distances and directions and kinds and conditions of roads. See letter attached.

*13. State source and quantity of water available for operations and its sufficiency at all seasons. State amount of power to be used, rate per hour or other cost, and source. Not applicable.

*14. Describe any existing useable facilities, equipment, buildings, or structure now on the property that will be devoted to the exploration work. Not applicable.

15. State in detail how the ore could be shipped and how and where milled. Not applicable.

*16. History:

(*a*) Give a statement, as complete as possible, of previous exploration, development, operation, and production of property, with reasons for any past suspensions of operations.

(*b*) State briefly the known history and production of adjoining and neighboring properties.

(*c*) Furnish any available (private) reports that may apply to this application, including results of mine examinations, recommended exploration and development, and metallurgical investigations.

*17. Production:

(*a*) If mine is in production, furnish the following information: Not applicable.

	Tons per day	*Grade or analysis*	*Cost per ton*	*Net value per ton*
(1) Mining				
(2) Milling				
(3) Shipped or sold				

*18. Ore or mineral reserves: (If property is or has been operating.) Not applicable.

(*a*) Describe the ore or mineral deposits briefly.

(*b*) Submit available maps and assay data.

(*c*) Give estimated tonnage and grade of each class of ore reserves.

19. State any conditions or circumstances regarding the property not sufficiently brought out by the foregoing questions. See letter attached.

THE EXPLORATION

20. For what mineral or minerals and for what types of deposits and ores will the exploration be conducted?

21. Describe briefly, but concisely, the proposed work and the estimated time required to complete it.

NOTE.—The Government will not participate in a project that will require more than 2 years to complete.

22. Furnish statement of the geological basis of the project with particular emphasis on factors leading the operator to expect the finding of commercial ore bodies. This statement should be accompanied by supporting maps such as geological maps, maps of the proposed openings and assay maps, sample lists, and other pertinent data.

THE REQUIREMENTS AND COSTS

23. Tabulate in the form of an itemized statement with a sum for each item the estimated requirements and costs of the project so that the total will give the estimated cost of the project in which the Government will participate, as follows:

(*a*) Labor, by numbers and classes (miners, muckers, millmen, etc.), with wages of each.

(*b*) Supervisors, by numbers and positions, with salaries of each.

(*c*) Cost of necessary repairs to existing facilities, structures, and buildings.

(*d*) Cost of necessary installation or construction of additional facilities, structures, and buildings.

(*e*) Cost of items of equipment, not now owned by the applicant which must be purchased for operations at a cost of $50 or more each.

(*f*) Cost of rental for equipment which the operator proposes to rent.

(*g*) Rental value of items of equipment which the operator now owns and which will be devoted to the work.

(*h*) Cost of materials and supplies, including items of equipment costing less than $50 each.

(*i*) Cost of power, water, utilities, and any other items not provided for above.

24. Furnish a time schedule of the project, stated in terms of months after project is approved, showing progress expected to be accomplished and the money expected to be spent.

CERTIFICATION

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

New York State Science Service
(Name of ~~company~~) state governmental agency

By John G. Broughton
(Signature of authorized official)

May 24, 1951
(Date)

State Geologist
(Title)

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

*Same as footnote on page 1.

16—64067-1 U. S. GOVERNMENT PRINTING OFFICE

4. The field work will be carried on under the general direction of John G. Broughton, State Geologist, and the specific direction of Benjamin M. Shaub, Temporary Geologist of the New York State Science Service, both of whom have directed identical work in New York State during the period 1946 - 1950. Broughton has done progressively responsible work in economic geology since 1936 and Shaub has been employed as mining engineer and geologist since 1929.

9. $4000 ~~+~~ scientific instruments and field equipment already in applicant's possession.

10. McKeever Quadrangle Lat. 43°30'-43°45'N Long. 75°00'-75°15'W

Loon Lake " Lat. 44°30'-44°45'N Long. 74°00'-74°15'W

16. (a) There has been no recorded production from any iron ore deposits in the Loon Lake Quadrangle. (b) Closest current production is from the "81" and "Chateaugay" mines, operated by the Republic Steel Corporation which are respectively 2½ and 5 miles east of the Loon Lake Quadrangle. Production from these mines had a value in 1949 of approximately $3,000,000. The Chateaugay mine has been operated practically continuously since 1863. The history of these mines are detailed in the article by J. R. Linney "A century and a half of development behind the Adirondack iron mining industry" on pages 480-487, of the Nov. 1943 issue of Mining & Metallurgy, herewith attached. (a) No production has been reported within the McKeever Quadrangle.

20. Exploration will be conducted for lenses and "veins" of magnetite (magnetic iron ore).

21. Systematic dip needle and dial compass surveys will be made in the Loon Lake Quadrangle and that portion of the McKeever Quadrangle not already completed by the N. Y. State Science Service field parties during the 1950 field season. The exact location of the surveys will be determined by the location of magnetic anomalies already located by aeromagnetic work. Unpublished maps indicating these localities have been supplied by the U.S. Geological Survey. Base lines are laid out along the trend of the assumed anomaly and side traverses are laid out at right angles to it. Magnetic readings are taken every 50 - 200 ft. feet along the base line and traverses and after plotting are contoured to delineate the anomaly.

It is believed that two four-man field parties could complete the McKeever Quadrangle and a large part of the Loon Lake Quadrangle in 2½ months time. If not completed during the summer of 1951, could be completed during 1952 field season.

22. Previous geological and geophysical field work in the Adirondacks has indicated that where a magnetic disturbance is present, it is, with minor exceptions, prima facie evidence of the presence of magnetic iron ore. This may be exposed at the surface or buried beneath deposits of sand, gravel or mud. Aeromagnetic surveys flown at a constant elevation tend to eliminate anomalies on mountain tops and minimize those in valleys or under a great thickness of alluvial or glacial cover. For that reason, a ground survey gives greater detail and accuracy and is absolutely necessary before sanction by core-drilling can be carried on.

The rocks in which the anomalies of the Beaver and Bear Lake Quadrangles occur are similar to those which contain commercial deposits of magnetite elsewhere in the Adirondacks and must therefore be considered worthy of investigation until proved otherwise.

23.

a. 2 party leaders	$2075.00
6 field assistants	2650.00
2 cooks	650.00
b. Temporary geologist (in charge)	1125.00
	6500.00
c. No charge.	
d. No charge.	
e. No charge.	
f. No charge.	
g. Dip needles, dial compasses, motor vehicles, diving accessories - No charge.	
h. Cost of materials and supplies	280.00
i. Travelling expense, automotive expense, fuel, light, power, water and food (while in field)	2250.00

24. It is expected that the work outlined above can be finished in 2½ months of working time and certainly before the end of the 1958 field season. Additional work will be carried on with non-competitive N.Y. State Science Service funds.

BUREAU OF MINES
COLLEGE PARK, MD.

1951 MAY 28 PM 1 : 32

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
JUN 1 - 1951
LANDON F. STROBEL
Executive Secretary

dma 1516X

THE UNIVERSITY OF THE STATE OF NEW YORK
NEW YORK STATE SCIENCE SERVICE
INCLUDING
STATE GEOLOGICAL AND NATURAL HISTORY SURVEYS
STATE EDUCATION BUILDING
ALBANY 1

May 22, 1951

Executive Officer
Defense Minerals Administration
Eastern Experiment Station
College Park, Maryland

Dear Sir:

You will find attached herewith an application for aid for an exploration project pursuant to Mineral Order 5, under the Defense Production Act of 1950. Inasmuch as the applicant is an official agency of the State of New York and not a private individual, partnership or corporation, many questions in form MF-103 are not applicable. For that reason, the following letter of explanation is somewhat expanded.

The New York State Science Service is applying for aid on an exploration project for iron ore which will cost $8000. It is understood that the Federal Government will contribute 50% of this sum, if the project is approved. Application is made in the light of a letter dated April 18, 1951 from J. L. Hofflund, General Counsel of the D.M.A. to Ronald B. Peterson, Acting Director, Bureau of Business Promotion, New York State Department of Commerce, in which Mr. Hofflund says in part, "There is no reason, so far as the United States is concerned, why a state acting through its authorized agencies could not receive aid under the Mineral Exploration Program."

As outlined on form MF-103 (attached), the project involves the carrying on of dip needle and dial compass surveys of certain areas in the McKeever and Loon Lake, N. Y. Quadrangles in which magnetic anomalies have been indicated as a result of aeromagnetic work carried on by the U.S. Geological Survey. The New York State Science Service began such surveys in 1946 and has carried them on since that year. Results of such a survey in the Russell, N. Y. Quadrangle are summarized in N.Y.S. Science Service Report of Investigation No. 2, herewith attached.

This project is already set up for further work during 1951 by the New York State Science Service. Additional Federal funds will simply aid in more rapid completion of the work. Actual location of the magnetic anomalies to be surveyed can be given at a later time if clearance for such use of the maps is given by the U.S. Geological Survey. In general, the anomalies are concentrated in the northeastern 1/4 of the McKeever Quadrangle and the northern 1/3 of the Loon Lake Quadrangle. Surveys are made wherever necessary, including both private and state lands.

Field work will be carried on by two four-man field parties which will be based in the field as close to the centers of activity as possible. Scientific equipment, transportation, tents, cots and other necessary equipment and supplies will be supplied by the State Science Service.

If deposits of magnetite are found and developed as a result of this magnetic exploration, it is obvious that neither the State of New York or any of its official agencies or employees can be obligated to repay the amount of Federal aid by a percentage royalty on the net proceeds of such development.

It is further understood that the exploration project will be under the direction of the New York State Science Service so that it can be integrated with its continuing program.

Additional supporting data and explanations can be supplied by the undersigned either by correspondence or by personal interview in Albany, New York or Washington, D. C.

Very sincerely yours,

John G. Broughton

John G. Broughton
State Geologist

JGB:fjh

Form MF-103
(April 1951)

U. S. DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS ADMINISTRATION

Budget Bureau No. 42-R1035.
Approval expires 6-30-51.

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

DO NOT FILL IN THIS BLOCK

Docket No. dma 1516 X

Date received 6-1-51

Participation

Name and address of applicant

Date

FILL IN THIS BLOCK

Date of application May 22, 1951

Estimated cost $8000

Mineral or metal Iron ore

Percentage of Government participation 50%

Location of mine McKeever and Loon Lake quadrangles, New York

Date of filing MF-100

DMA Docket Number, if available

INSTRUCTIONS

Read Mineral Order 5, Regulations Governing Government Aid in Defense Projects, before completing this application. Submit four signed copies of the application to Defense Minerals Administration, Department of the Interior, Washington 25, D. C., or to the nearest field executive officer thereof, with your name and address on each sheet of the application and all accompanying papers. If any question is inapplicable, or if you cannot answer it, so state on the form. Where the space provided for answer is insufficient, answer on a separate sheet, annex it to the application form, and refer to it in space for answer. If the application is approved, you will be presented with an exploration project contract on Form MF-200, for your signature.

THE APPLICANT

*1. Is applicant an individual, partnership, or corporation? See letter attached.

*2. If a partnership, state names and addresses of partners. " " "

*3. If a corporation, state names and addresses of officers, directors, and five largest stockholders. See letter attached.

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

*5. Are you the owner or the lessee of the property? See letter attached.

6. If owner, state what claims, liens, or encumbrances, if any, are against the property. See letter attached.

7. If lessee, attach a copy of the lease and state if it is in good standing. See letter attached.

NOTE.—It will be necessary to procure and attach to the exploration project contract agreements of claimants, lienors, encumbrances and lessors subordinating their interests in the property to the interest of the Government under the contract.

8. Furnish current financial statement, showing assets and liabilities, and a profit and loss statement See letter attached

9. How much money is applicant prepared to invest in proposed project? Is it sufficient to pay your part of the cost of the project as detailed in question 23 of this application form, in accordance with the regulations on Government participation (Section 9 of Mineral Order 5)?

*If you have already answered these questions on MF-100, you are not required to answer the questions for this application.

16—64067-1

THE PROPERTY

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

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

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

*11. State the present and former names of the property, if any. See letter attached.

*12. State, in detail, the location of the property with reference to towns, railroads, roads, shipping points, including distances and directions and kinds and conditions of roads. See letter attached.

*13. State source and quantity of water available for operations and its sufficiency at all seasons. State amount of power to be used, rate per hour or other cost, and source. Not applicable.

*14. Describe any existing useable facilities, equipment, buildings, or structure now on the property that will be devoted to the exploration work. Not applicable.

15. State in detail how the ore could be shipped and how and where milled. Not applicable.

*16. History:

(*a*) Give a statement, as complete as possible, of previous exploration, development, operation, and production of property, with reasons for any past suspensions of operations.

(*b*) State briefly the known history and production of adjoining and neighboring properties.

(*c*) Furnish any available (private) reports that may apply to this application, including results of mine examinations, recommended exploration and development, and metallurgical investigations.

*17. Production:

(*a*) If mine is in production, furnish the following information: Not applicable.

	Tons per day	*Grade or analysis*	*Cost per ton*	*Net value per ton*
(1) Mining				
(2) Milling				
(3) Shipped or sold				

*18. Ore or mineral reserves: (If property is or has been operating.)

(*a*) Describe the ore or mineral deposits briefly.

(*b*) Submit available maps and assay data.

(*c*) Give estimated tonnage and grade of each class of ore reserves.

19. State any conditions or circumstances regarding the property not sufficiently brought out by the foregoing questions. See letter attached.

THE EXPLORATION

20. For what mineral or minerals and for what types of deposits and ores will the exploration be conducted?

21. Describe briefly, but concisely, the proposed work and the estimated time required to complete it.

NOTE.—The Government will not participate in a project that will require more than 2 years to complete.

22. Furnish statement of the geological basis of the project with particular emphasis on factors leading the operator to expect the finding of commercial ore bodies. This statement should be accompanied by supporting maps such as geological maps, maps of the proposed openings and assay maps, sample lists, and other pertinent data.

THE REQUIREMENTS AND COSTS

23. Tabulate in the form of an itemized statement with a sum for each item the estimated requirements and costs of the project so that the total will give the estimated cost of the project in which the Government will participate, as follows:

(*a*) Labor, by numbers and classes (miners, muckers, millmen, etc.), with wages of each.

(*b*) Supervisors, by numbers and positions, with salaries of each.

(*c*) Cost of necessary repairs to existing facilities, structures, and buildings.

(*d*) Cost of necessary installation or construction of additional facilities, structures, and buildings.

(*e*) Cost of items of equipment, not now owned by the applicant which must be purchased for operations at a cost of $50 or more each.

(*f*) Cost of rental for equipment which the operator proposes to rent.

(*g*) Rental value of items of equipment which the operator now owns and which will be devoted to the work.

(*h*) Cost of materials and supplies, including items of equipment costing less than $50 each.

(*i*) Cost of power, water, utilities, and any other items not provided for above.

24. Furnish a time schedule of the project, stated in terms of months after project is approved, showing progress expected to be accomplished and the money expected to be spent.

CERTIFICATION

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

New York State Science Service
(Name of company) state governmental agency

By John G. Broughton
(Signature of authorized official)

May 24, 1951
(Date)

State Geologist
(Title)

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

*Same as footnote on page 1.

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4. The field work will be carried on under the general direction of John G. Broughton, State Geologist, and the specific direction of Benjamin H. Shaub, Temporary Geologist of the New York State Science Service, both of whom have directed identical work in New York State during the period 1946 - 1950. Broughton has done progressively responsible work in economic geology since 1936 and Shaub has been employed as mining engineer and geologist since 1929.

9. $4000 + scientific instruments and field equipment already in applicant's possession.

10. McCleaver Quadrangle Lat. 43°30'-43°45'N Long. 75°00'-75°15'W

Loon Lake " Lat. 44°30'-44°45'N Long. 74°00'-74°15'W

16. (a) There has been no recorded production from any iron ore deposits in the Loon Lake Quadrangle. (b) Closest current production is from the "Oil" and "Chateaugay" mines, operated by the Republic Steel Corporation which are respectively 2½ and 9 miles east of the Loon Lake Quadrangle. Production from these mines had a value in 1949 of approximately $3,000,000. The Chateaugay mine has been operated practically continuously since 1863. The history of these mines are detailed in the article by J. E. Linney "A century and a half of development behind the Adirondack iron mining industry" on pages 430-437, of the Nov. 1943 issue of Mining & Metallurgy, herewith attached. (a) No production has been reported within the McCleaver Quadrangle.

20. Exploration will be conducted for lenses and "veins" of magnetite (magnetic iron ore).

21. Systematic dip needle and dial compass surveys will be made in the Loon Lake Quadrangle and that portion of the McCleaver Quadrangle not already completed by the N. Y. State Science Service field parties during the 1950 field season. The exact location of the surveys will be determined by the location of magnetic anomalies already located by aeromagnetic work. Unpublished maps indicating these localities have been supplied by the U.S. Geological Survey. Base lines are laid out along the trend of the assumed anomaly and side traverses are laid out at right angles to it. Magnetic readings are taken every 50 - 200 ft. feet along the base line and traverses and after plotting are contoured to delineate the anomaly.

It is believed that two four-man field parties could complete the McCleaver Quadrangle and a large part of the Loon Lake Quadrangle in 2½ months time. If not completed during the summer of 1951, could be completed during 1952 field season.

22. Previous geological and geophysical field work in the Adirondacks has indicated that where a magnetic disturbance is present, it is, with minor exceptions, prima facie evidence of the presence of magnetic iron ore. This may be exposed at the surface or buried beneath deposits of sand, gravel or mud. Aeromagnetic surveys flown at a constant elevation tend to emphasize anomalies on mountain tops and minimize those in valleys or under a great thickness of alluvial or glacial cover. For that reason, a ground survey gives greater detail and accuracy and is absolutely necessary before testing by core-drilling can be carried on.

The rocks in which the anomalies of the McKeever and Moon Lake Quadrangles occur are similar to those which contain commercial deposits of magnetite elsewhere in the Adirondacks and must therefore be considered worthy of investigation until proved otherwise.

23.

a. 2 party leaders	$1075 00
6 field assistants	2650 00
2 cooks	650 00
b. Temporary geologist (in charge)	1175 00
	5550 00
c. No charge.	
d. No charge.	
e. No charge.	
f. No charge.	
g. Dip needles, dial compasses, motor vehicles, living accomodations - No charge.	
h. Cost of materials and supplies	200 00
i. Traveling expense, automotive expense, fuel, light, power, water and food (while in field)	2250 00

24. It is expected that the work outlined above can be finished in 2½ months of working time and certainly before the end of the 1952 field season. Additional work will be carried on with non-cooperative N.Y. State Science Service funds.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
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LANDON F. STROBEL
Executive Secretary

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MINING and METALLURGY

November 1943

Editorial Comment by A. B. Parsons

Mining Iron Ore in the Adirondacks

DESPITE the fact that iron mining in the Adirondack region of northern New York dates back to the Revolutionary War; and the further fact that, in the 1880's, mines in the area accounted for nearly one fourth of the iron ore produced in the United States, Adirondack iron mining is just now, for the first time, assuming the importance that is justified by the size and character of the ore deposits. Sometime during 1944, production of high-grade magnetite sinter, ranging from 60 to 68 per cent iron, should attain an annual rate of 4,000,000 long tons from six separate mines. Of these, three will be operated by the Republic Steel Corporation and one each by the National Lead Company, the Jones & Laughlin Steel Corporation, and The M. A. Hanna Company. Part of the needed capital was supplied by the corporations themselves and part by the Defense Plant Corporation (Reconstruction Finance Corporation), the investment of new funds totaling about $40,000,000. Naturally the cost in normal times would be somewhat lower.

To produce 4,000,000 tons of sinter, about 11,000,000 long tons of ore will be mined: roughly half will be by underground methods and half by power shoveling in opencuts. After preliminary crushing, some of the leaner rock will be "cobbed" out in relatively coarse size; but the great bulk will be crushed and ground to finer sizes for concentrating in wet magnetic separating machines. The fine concentrate will then be dewatered by vacuum filtration and sintered to produce a hard, low-phosphorus, agglomerated product ideally suited both chemically and structurally for the blast furnace or for direct feeding to open-hearth or electric steelmaking furnaces.

Mining and beneficiating some 35,000 tons of hard, tough ore per day involves use of a large amount of machinery, equipment, and supplies of many kinds, as well as technologic and engineering talent of high order. The purpose of this special issue of MINING AND METALLURGY is to give the profession an over-all picture of this significant development, including its vital strategic importance in helping the steel industry perform its part in waging global war.

It should not be concluded from the foregoing that the new and revamped enterprises are in any sense "war babies" that will lapse into inactivity when the enemies of the United Nations have been defeated. The best evidence that iron mining in the Adirondacks is on a sound economic footing is that the Republic Steel Corporation, acting on the recommendation of its vice-president, Donald B. Gillies, completed negotiations for the lease of the Witherbee Sherman properties, at Mineville, in June of 1938. If the Republc Steel executives made this commitment only because they foresaw the United States entering a great war three and one half years later they are endowed with prescience that is more than phenomenal.

WHAT were the changes in the situation that justified four successful corporations in undertaking exploitation of these large ore deposits? Four of them, though well known, had long lain dormant; and though the other two, at Mineville and Lyon Mountain, had been operated intermittently they had never returned very substantial profits to the companies that controlled them.

Among factors on the technologic side were progress in the arts of mining and treating the ores. Better equipment and methods made mining

less expensive than it had been. One important development was the displacement of dry magnetic separators by wet machines of improved design. Not only does this ameliorate the dust problem; it also permits the making of a concentrate from a given ore lower in phosphorus, because finely pulverized phosphorus-containing minerals are much more effectively removed by wet methods than by dry.

Modifications in steelmaking practice placed an additional premium on the low phosphorus content of Adirondack sinter and on its distinctive physical characteristics. Large, hard, chunks of sinter can be fed as an alternate to heavy-melting scrap directly to open-hearth or electric steel furnaces. The sinter likewise makes an excellent constituent of a blast-furnace charge.

The economics of the iron-ore business is complex. In it are involved considerations of taxes, royalties to fee owners, depletion charges, and transportation costs by water and rail. However, the trend has been in the direction of improving the competitive position, as compared with Lake Superior ores, of Adirondack magnetites. The advantages of all-year uniform rail transportation to steel plants at Buffalo, Bethlehem, Cleveland, and Pittsburgh—coupled with the high quality of the sinter—are today recognized more clearly than they have been heretofore. Gradual depletion of the higher-grade hematite ores of the Lake Superior region has been and will continue to be a factor in augmenting the relative value of the Adirondack ores. It should be mentioned, with respect to the National Lead Company's MacIntyre project, that the primary purpose was to obtain much needed titanium; magnetite was a secondary consideration.

How extensive are the magnetite resources of the Adirondack region and how long may the mining industry be expected to flourish? Some observers, quite seriously, forecast a drastic shrinkage in the use of steel—particularly in the tonnage required of new production. They see aluminum and magnesium—the duo of light metals now so much in the limelight—as well as plastics and plywood as displacing steel to some extent for sundry structural and other purposes. However, no informed person is disposed to read steel out of the competitive industrial picture. As long as steel is required in large quantities it is reasonable to expect that Adirondack iron ores, in increasing quantity, will find a profitable market. Rational conjectures as to resources of ore, minable under present conditions, range to 800,000,000 long tons. Geological conditions are such that the development of exceedingly large deposits of leaner ores can be expected. If experience is a safe guide it is likely that ores of progressively lower grade will be exploited successfully.

No evidence suggests that northern New York will ever approach northern Minnesota in the eventual output of iron; but the present expansion should mark the beginning of a long period of activity in Adirondack iron mining.

MINING AND METALLURGY, the mining industry, and the profession are indebted to those who in one way or another contributed to the success of this Adirondack number of the magazine. Among them are the high officials of the four companies already mentioned; the Honorable Charles B. Henderson, Chairman of the Reconstruction Finance Corporation, who arranged clearance with the various Government agencies; and the engineer-authors of the various papers who, to prepare their manuscripts, took arduous hours from crowded days. It is the willingness of competent men to describe the details of their work, even at some personal sacrifice, that has made possible the healthy progress that has always characterized mineral-industry engineering and technology.

Economics of the Current Revival in Adirondack Iron Ore Mining

By D. B. Gillies
Vice-President,
Republic Steel Corp.; Past President,
A.I.M.E.

Donald B. Gillies

IN 1938 the Republic Steel Corp. announced that it had leased the ore mines and other property of the Witherbee Sherman Corp. at Port Henry, N. Y. The announcement brought forth an interesting reaction. Two questions were asked repeatedly:

(1) Is the iron product high grade?

(2) Is there a substantial reserve?

The answer to both questions was and is a decided and emphatic "Yes."

Though iron ore is found in virtually every state in the Union, it is mined on a commercial basis in less than a dozen. Among these are: Minnesota, Michigan, Wisconsin, New York, Alabama, New Jersey, Pennsylvania, Utah, and perhaps a few others producing small tonnages. Large deposits also exist in other states, but they remain almost entirely untouched, partly because we have been spoiled by the high-grade seemingly inexhaustible fields in the Lake Superior region, and partly because these unmined deposits are usually too far removed from markets and manufacturing facilities.

Odd as it may seem, the ore mines in New York State are among the oldest in the country, but for many years were virtually forgotten by the steel industry. The first mines were opened almost a century and a half ago. Benedict Arnold in his Regimental Book tells of sending men to Port Henry to dig iron ore in 1775. Tradition says that the cannon at Fort Ticonderoga were made from this ore. For many decades thereafter the Adirondack region supplied a large part of the iron ore used in our own expanding country. Always, though, transportation difficulties were present; there was the problem of bringing ore from inaccessible mines in mountainous country to the market.

At the same time, population and industry were moving westward. In 1844 ore was discovered in northern Michigan and the first shipment of approximately five tons moved southward six years later. Small ore movements became larger as more mills were built west of the Alleghenies. In 1890 the Merritt brothers discovered the Mesabi Range and with their discovery came the birth of the modern steel industry. It is little wonder, therefore, that the Adirondack workings should, with only two or three exceptions, sink from public notice. Table 1 shows the relative importance of iron ore mining areas in the United States.

TABLE 1. Iron Ore Mined in the United States

District	Per Cent of Total 1918-1928	1941
Lake Superior	84.5	85.3
Birmingham, Ala., Chattanooga, Tenn.	10.2	8.3
Adirondack, N. Y.	0.6	3.6
Northern New Jersey and Southeastern New York	0.8	0.7
Other Districts	3.9	2.1

In 1938, therefore, when Republic announced its entrance into the Adirondacks, the region was little known or appreciated. Now why did Republic lease the Witherbee-Sherman property and one year later the Lyon Mountain mine of the Chateaugay Ore & Iron Co.?

Shortly after the middle of the 1930's, studies confirmed the general realization that deposits of high-grade ore in the Lake Superior district were not unlimited and might well be economically exhausted sometime in the not too distant future. As war clouds became faintly visible in European skies, Republic's executives became genuinely concerned about the ore situation. Should a widespread war start, there was every reason to believe that the United States would be expected to furnish munitions in quantity. This would mean more rapid depletion of the high-grade Lake Superior ores and would bring steel companies face to face with the serious question of decreased iron ore reserves, whose end, authorities estimated, would come as early as 1950 to 1954. In addition to the threatened depletion of Lake Superior's ore reserves, short shipping seasons and vessel shortages are ever-present uncertainties. Furthermore, for the past forty years no new discoveries of importance have been made in the northern ore fields or, for that matter, in the United States as a whole.

Taking all of these factors into consideration, Republic's management believed it wise to seek another source of high-quality supply, with sufficient reserves to ensure long life together with assured all-year shipments by rail or rail and water. It so happens that I had long been familiar with the Adirondacks and their possibilities, and no extended argument was necessary to convince my associates that a careful study should be made. As a result, in 1938 Witherbee Sherman was leased for 25 years with a renewal clause covering an additional quarter of a century, and in 1939 Republic acquired by lease the property of the Chateaugay Ore & Iron Co. at Lyon Mountain for a like period. Our present experience has confirmed our opinion of some years ago that the Adirondack region can supply a substantial proportion of the high-quality ore required by our steel mills.

Now to take up the two questions earlier mentioned. The first was: Is the iron product high grade?

The iron content of Adirondack ores varies from the almost pure magnetite found in some of the Mineville openings down to the 22 or 25 per cent iron content which is currently the lower limit for profitable concentration. As the Adirondack ore reserves are figured today, the average ore of the region would probably fall not much above 35 per cent metallic iron. This means that the typical ore is about half magnetite and half gangue rock by weight.

RICHEST of the ore from our underground mines in the Adirondack region is that from the Old Bed deposit at Port Henry. Approximately 20 per cent of the Old Bed production, or 140,000 long tons per year, can be separated from the total mine output into lump ore that will contain 61 per cent iron. This is of equal quality with the rapidly decreasing lump ore of the Lake Superior region and, although containing some excess phosphorus, has been found to be an excellent open-hearth feed ore. Operating cost figures indicate that this material can be delivered to steel plants in the Pittsburgh or Valley region at a cost that is competitive.

These ores lend themselves admirably to concentration and sintering to produce excellent open-hearth charge ore and blast-furnace sinter, and so establish the economic value of the ores from this entire region. They are ground to approximately 10 mesh and concentrated by a relatively simple magnetic concentration operation, as outlined in other papers in this issue, so that when the concentrate is sintered the product averages 68.5 per cent iron. We have been able to secure an iron concentrate as high as 71.9 compared to the theoretical composition of pure magnetite of 72.4 per cent iron, but this grade has not been found to be suitable for the manufacture of good sinter.

Adirondack sinter is highly desirable for use in the open hearth as charge ore. Many tests have been made in the open hearths of Republic which demonstrate the superiority of magnetite sinter over Lake Superior soft ores. High-iron charges (55 per cent and over) are substantially aided by the use of this material, which results in an increased tonnage of steel ingots per furnace hour, decreased fuel consumption, and added safety to the open-hearth workmen.

The magnetic properties of this sinter lend themselves to easy handling by magnet, permitting rapid loading of charging boxes. Its moisture content is extremely small so that freezing difficulties in winter are reduced to an absolute minimum.

For the past five years Republic has been using a large amount of sinter in its blast furnaces. Increasing the percentage of sinter in the blast-furnace burden to as much as 40 to 45 per cent of the metallic charge raises production from 10 to 19 per cent, coke consumption is thereby decreased approximately 15 per cent, flux consumption lowered approximately 20 per cent, and flue-dust production cut down as much as 50 per cent. Use of Adirondack magnetite sinter in place of Lake Superior soft ores therefore results in many blast-furnace savings.

However, there is another side. It must remain competitive with Lake Superior ore on a price per iron unit delivered at the furnace. For example, a comparison of Adirondack sinter with Lake Superior Mesabi ores, which contain 51.5 per cent iron delivered to the Mahoning Valley, at the market price of $4.45 per long ton, would be shown in Table 2.

TABLE 2. Iron Ore Costs Compared

Break-even Point, with Market-priced Mesabi-Lake Ores Delivered to Mahoning Valley

	Cost per Long Ton	Cost per Long Ton Unit of Iron
Lake Ores (51.5 per cent iron)		
Market Price (Rail or Vessel—Lower Lake Ports)	$4.45	$0.0864
Handling and Freight (including Federal railroad tax)	1.00	0.0194
	$5.45	$0.1058
Adirondack Sinter (68.5 per cent iron)		
Break-even Mining and Preparation Cost	$4.59	$0.0670
Freight to Steel Mills	2.66	0.0388
	$7.25	$0.1058

The $4.59 break-even point must include the mining, concentrating, and sintering cost, taxes, royalties, depreciation, amortization, overhead, and profit. In view of the fact that from 1.25 to 3 tons of underground ore must be mined in order to produce a ton of shipping product, it is obvious that any increase in costs, such as taxes, might again relegate the Adirondack ore region to its former position. But five years of experience with Adirondack mines has proved that they can play an important part in the steel industry unless unfavorable economic factors not now discernible and beyond our control are brought into the picture.

The next question was as to the ore reserves in the Adirondack region. If one wishes to be accurate, the answer to this question is that no one knows exactly. Approximately 12,000 square miles in northern New York State is iron-bearing territory, an area that stretches 100 miles from east to west and roughly 125 miles from north to south. Many estimates have been made as to the reserves in the district. In 1935, for instance, they were placed at 600 million tons of magnetite ore and two billion tons of titaniferous ore. No estimate can be more than a guess, however, due to the geological formation of the territory and to the fact that modern scientific exploration has been made in only a portion of the region. Exploration on our own properties has clearly proved that ample ore exists, of a type highly desirable to carry Republic through the period of its leases.

As an example of the productiveness of the region, the Witherbee-Sherman properties may be regarded as typical. They have produced, since operation started in 1870, approximately 31 million long tons of ore, in spite of the fact that the mines were closed for many of the intervening years. That they are capable of a substantial expansion is shown by the fact that in 1935 the Adirondack district produced less than 300,000 long tons, whereas seven years later the output was in excess of 3,000,000 long tons of crude ore. This ore was chiefly magnetite, produced in the underground operations of Republic's properties in this section. Operating at full capacity Republic's expanded properties should have a capacity to produce approximately 2,250,000 long tons of sinter averaging 68.5 per cent iron, 2 per cent silica, and an extremely low percentage of phosphorus.

The fact that other steel companies are beginning to develop properties would indicate that they, too, believe that the Adirondacks constitute a valuable reserve for the American steel industry. In our estimation the Adirondack region is of utmost importance to the well-being not only of the steel industry, but of the nation as a whole.

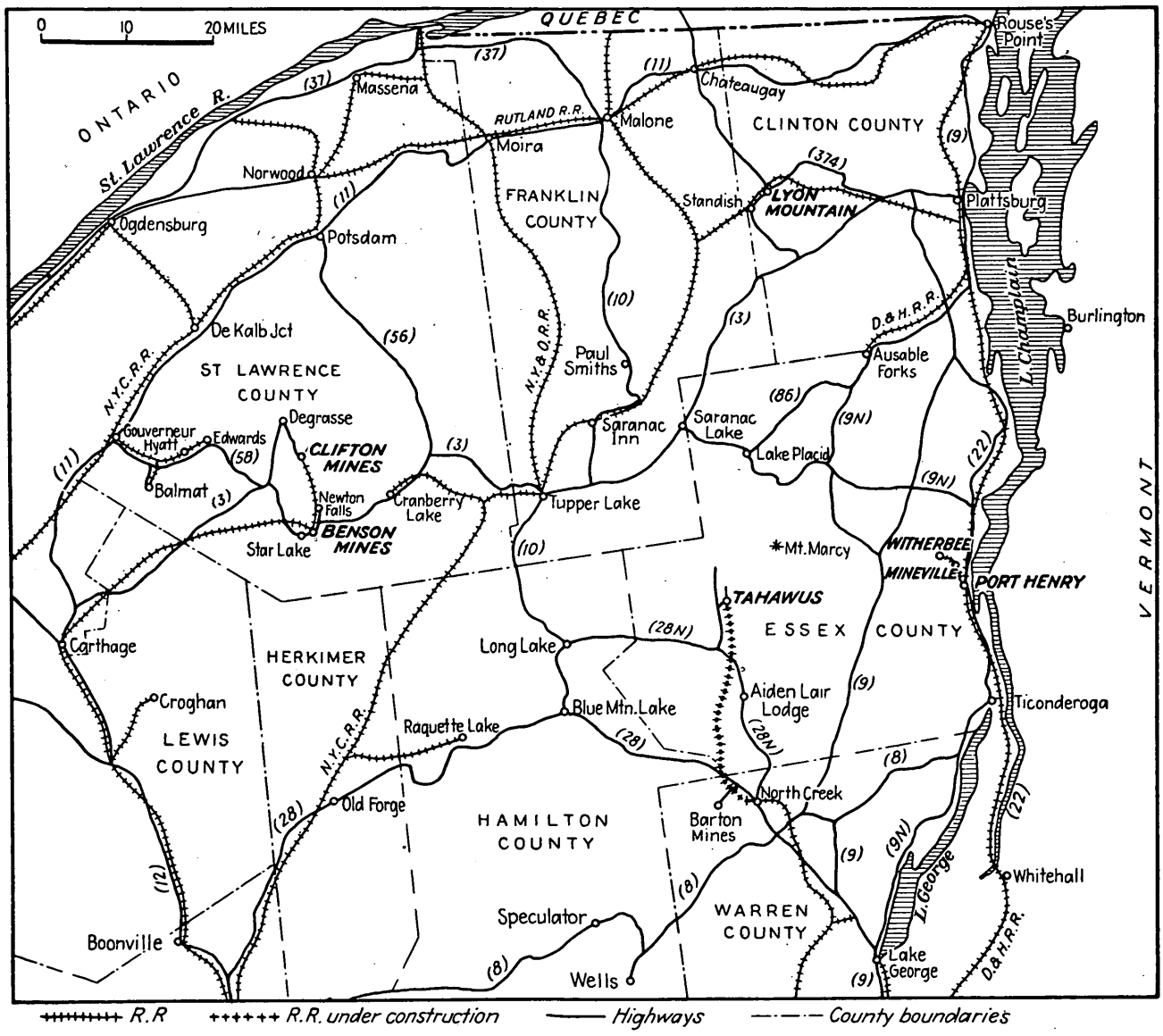
A Century and a Half of Development Behind the Adirondack Iron Mining Industry

By J. R. Linney
Manager, Adirondack District,
Republic Steel Corp.;
Member, A.I.M.E.

A HISTORY of the ore-mining and iron-smelting industry of the Adirondacks comprises a century and a half of pioneering by rugged individualists, both men and women. By geographical location, the climate is most severe—long, cold winters with heavy snowfall, and short seasons of vegetation growth; this, together with its remote location from large centers of population, adds considerably to the difficulties of conducting mining operations in this area. Many stories of adventure and romance have come to my attention during 25 years of professional life in the district.

To go back to the earliest reports of the exploitation of the magnetite ore of this region, Benedict Arnold, in his campaigns through Lake Champlain into Canada during the American Revolution, is said to have constructed his warships and bateaux at Whitehall, at the extreme southern end of Lake Champlain, securing iron ore from its westerly shores in the vicinity of Port Henry, smelting and forging it into armament and cannon balls.

Although much earlier developments in the iron industry in northern New York may have existed, the earliest de-



Sketch map of the Adirondack region in northern New York State showing location (in bold-face lettering) of the principal operating iron mines.

velopment of record seems to be the construction and operation of the first Catalan forge in 1798 on the Saranac River in Plattsburg, by Platt. Soon after, in 1801, Levi Highbey and George Throop erected an ironworks at Willsboro Falls on the Boquet River near Lake Champlain. In the same year, Liberty Newman erected an ironworks at the upper falls on the outlet of Lake George in Ticonderoga, and during the same period records indicate the erection of a rolling mill on the Boquet River near Essex, the iron being shipped to a nail factory in Vermont. In 1802, an ironworks was established at New Russia, Essex County, some of the ore used coming from the Fisher Hill ore bed, Mineville.

In 1803, William Bailey erected a Catalan forge on the Chateaugay River about five miles below the outlet of Lower Chateaugay Lake. He obtained his ore from the old opening known as the Prall vein, which is identical with the present 81 mine of the Chateaugay ore bed. At Ferronia, in the town of Ausable, what is known as the Arnold Hill iron ore mine was discovered by Samuel Baker in 1806. Three years later Archibald McIntire erected an ironworks within the limits of the present town of North Elba, Essex County, the ore used coming from the Arnold bed in the town of Ausable. A rolling mill was constructed and operations commenced by the Keeseville Rolling and Slitting Mill Co. at Keeseville, in 1815, the principal product of the company being nail-plate which was subsequently cut into strips for the manufacture of horseshoe nails.

In 1822, Major James Dalliba, in connection with John D. Dickenson, of Troy, erected the first furnace at Port Henry. The ore used was obtained from a vein near the furnace, the same vein from which Arnold secured his ore a half century before. In 1823, the Chateaugay ore body, at what is now Lyon Mountain, was said to have been discovered by a trapper named Collins. A year later the Peru Iron Co. was organized with a capital of $200,000, operating forges and rolling mills along the Ausable River, and in 1826, two blast furnaces, together with a rolling mill, were put into operation at Clintonville by the same company. Charged with wood and charcoal, and blown by cold blast, ironware as well as pig iron was produced, castings being poured direct from the furnace. In January, 1828, a cable factory, manufacturing large ship anchors and iron cables, was erected, and in that same year a four-fire Catalan forge was built six miles west of Lake Champlain on Putnam's Creek, near Crown Point. A good grade of iron was evidently manufactured here, for the U. S. Government ordered a large quantity, to be fabricated into chain cable. In 1831, J. & J. Rogers began making iron at their Catalan forges in Black Brook, securing the ore from Arnold Hill.

The small iron mining and smelting enterprises in subsequent years are too numerous to mention, so the rest of this narrative will be confined to those of present-day commercial significance.

Sixty-four years ago Clinton and Essex Counties produced 23 per cent of the total iron output of the United States. The largest and most consistent contributors were the Mineville (Port Henry) and the Chateaugay (Lyon Mountain) operations.

Mineville (Port Henry)

PRESENCE of large quantities of iron ore in Mineville, within the limits of the town of Moriah, was indicated during the earliest compass surveys in 1810, when what was known as the "Kellogg Survey" was being made. So strong was the evidence that certain lots were called the "Iron Ore Tract." Fine specimens of iron ore were found but the mines thus indicated were not opened until fourteen years later, in 1824, when Harry Sherman and Elijah Bishop each agreed to pay D. E. Sandford $100 for a fourth interest in his property, and active operations were begun, most of the ore being hauled by ox teams over a plank road to Port Henry for smelting.

Another deposit, the Cheever ore bed, had been discovered in 1804, but not much progress had been made toward developing it until 1821, when Charles Fisher obtained a lease, paying an annual rental of ten tons of "bloom iron." The ore was smelted in Major Dalliba's blast furnace at Port Henry, already mentioned.

In 1849 the Sandford ore bed came into the possession of S. H. & J. G. Witherbee and the descendants of Sherman, who later incorporated as Witherbee, Sherman & Co., and still later took over the mines of the Port Henry Iron Ore Co.

Witherbee Sherman, through the aggressiveness of its ownership and management, developed into one of the most successful and prosperous enterprises of its day. Through the inventive efforts of its engineers and management, the famous Ball & Norton magnetic separator was developed. This company plowed back a great deal of its earnings into acquiring additional iron ore lands, exploration work, including diamond drilling, and the opening of new ore beds, such as Old Bed, Harmony, New Bed, Barton Hill, Bonanza, Fisher Hill, Cook, and Sherman. During the first World War the company was an

J. R. (Joe) Linney

important contributor to the country's supply of iron. Then, because of vast changes in the iron and steel industry, such as the trend from cast iron to steel, the company suffered severe setbacks and decided in 1938 to lease its iron-ore properties to Republic Steel Corp.

Republic, through its engineering and metallurgical talent, made a complete and comprehensive study of the property; it quickly recognized the advantage that might be obtained from this high-grade iron ore; at the same time realizing the economic difficulties in producing this ore in competition with the relatively low-cost iron ores from the Great Lakes district. Plans were made, now successfully carried out, for the sinking of new shafts, opening additional ore mines, proper development, changes in mining practice, the purchase of up-to-date mining equipment, including wet drilling and adequate ventilation, and the building of a wet concentrator—all to eliminate the hazards of silicosis and to secure the most economical operation. The blast furnaces at Port Henry, idle for many years, were scrapped in 1940, as the ore was shipped direct to the Company's blast furnaces and elsewhere.

Chateaugay (Lyon Mountain)

SOME fifty miles north of Port Henry the iron business took on impetus after Platt built his blast furnace in 1798. Year after year new ore deposits were discovered and ironworks started. The Saranac River, with its many rapids and falls, was a fruitful source of power. Timber for charcoal was abundant and ore beds were numerous, so several ironworks operated successfully for many years, and this section of northern New York became a large and important part of the American bloomery.

Closely associated with this industry were two men, Andrew Williams and Smith M. Weed, the founders of the Chateaugay Ore and Iron Co. Wil-

liams, when a young man, began work at one of the Catalan forges on the Saranac River. With a good common-school education, he applied himself diligently until he became one of the best informed and ablest men in the industry, always endeavoring to improve the quality of his iron, continually prospecting and seeking purer and better ore deposits. Several years before the opening of the Chateaugay ore beds, Williams had secured test lots of this ore, packed them many miles through the forests to his forge on the Saranac River, made up special lots of iron from them, and asked selected customers to report back as to the quality. The splendid reports on the iron made from Chateaugay ore and the many requests for more of it caused Mr. Williams to become much interested in the opening and development of the Chateaugay ore bed, despite its inaccessibility. Williams's associate. Weed, graduated from the Harvard Law School in 1857. and in later years proved himself both an able lawyer and a statesman of first rank.

In 1781, the Legislature of New York set apart. in the north central part of the State, a tract of land containing about 665,000 acres, lying in Clinton. Franklin, and Essex Counties, to satisfy the claims of two regiments of soldiers which the State had found it necessary to raise to protect its frontier settlements from frequent pillage by the Indians and other enemies. This grant became known as the Old Military Tract. The Chateaugay ore bed lies in this tract.

Several miles westward of the Chateaugay mine, and on the same strike as the Chateaugay ore bed, is an old opening (81 mine), which had evidently been worked to a considerable extent at some remote period, a shaft having been sunk from which quantities of waste which today would be good ore had been thrown out and left. Trees of considerable size had grown over some of this waste pile. Probably this is the so-called Prall vein, from which Bailey obtained his ore in 1803, but no record seems to exist of the actual discovery of the Chateaugay ore bed up to the time that Lloyd N. Rogers purchased the land containing it in 1822. In the following year the trapper Collins is credited with having discovered the bed of ore. practically phosphorus free, now known as "Chateaugay."

Even after the ore bed was known it excited little interest among capitalists. for it was far from lines of transportation. lying in a region abounding in natural obstacles, held to be practically insurmountable against the building of roads of any kind. So not until 1868 were the first steps taken toward utilizing this treasure. In that year Foote, Weed, Meade, and Waldo made a contract with Edmund Law Rogers, of Baltimore, son of Lloyd N. Rogers, and soon after obtained possession of the property. Even then, little development was done in the next five years. Small groups of men dug ore during the summers, piling it on the surface to be loaded during the winter months and hauled by horse-drawn sleighs through the dense wilderness to the Catalan forges on the Saranac River.

Open-pit mining of ore in the Chateaugay vein, 1878.

For four years, working of the ore was confined practically to the outcroppings. loading by hand directly into wagons. As the pits became deeper, the sides were sloped on a grade which permitted the driving of the wagons on the floor of the bed. This method soon became impractical so the ore was thereafter loaded into small cars and hoisted to the surface by means of a whimsey, with power supplied by horses. The ore was then transferred to wagons and hauled to the separator on the bank of Separator Brook at Lyon Mountain.

In subsequent years, the property was opened up considerably. The mines were sunk deeper, necessitating larger hoisting equipment and also the introduction of pumping machinery. Until this time, all the drilling was done by hand. using jumpers and hammers, two men drilling on the average twelve lineal feet per shift.

A small dam on Separator Brook, which comes brawling down from Mount Lyon. secured a head of 48 ft., sufficient to run the separator a good portion of the year; it was supplemented by a 30-hp. steam engine. The Chateaugay Ore and Iron Co. now owned over 35,000 acres of land in this immediate region, much of it covered with heavy timber, well adapted to lumbering and charcoaling purposes. They also had a forty-year lease on 4000 additional acres which included the ore bed, with the privilege of cutting every tree which grew upon it.

In 1874, twenty Catalan forges, together with charcoal kilns, were erected at the outlet of Chateaugay Lake, at Belmont. The entire operations were driven by water power under a head of 18 ft. The "mill pond" was twelve miles long, both Upper and Lower Chateaugay Lakes having been raised by the dam about 4½ ft. All the wood, coal, and ore were moved on the lake in barges hauled by steamboat in summer and by horses and sleds over the snow in winter. The blooms and billets of almost pure iron were hauled by wagons and sleighs to Chateaugay and shipped via the Ogdensburg & Lake Champlain R.R. to Pennsylvania and Ohio steel mills.

The Catalan forge furnace, in which iron was made direct from ore, was an open hearth, about 2½ by 3½ ft., with a stack 20 to 25 ft. high. Blast was furnished either by a bellows, or by means of a trompe. The pipe that carried the air to the hearth was coiled in the stack of the furnace, the object being to preheat the blast, thus saving fuel. The operation consisted of a charcoal fire. stimulated by a blast of air, to which iron ore and charcoal in small quantities were added alternately by the bloomsmen, who also regulated and adjusted the fire, until the batch of iron. called a "loupe," weighing about 300 lb., was made. This usually took about three hours.

This early period of development was accompanied by a great deal of hardship for both the management and the employees. The winters were cold. with heavy snows, food and clothing hard to get. though venison, rabbits, birds. and fish were quite plentiful. Flour was expensive and lacking for months at a time.

Late in the '70s, the Company realized that it must secure railroad communication with the great iron markets of the country. One possible route was down the Chateaugay valley to Chateaugay, there connecting with the Ogdensburg and Lake Champlain R.R.; the other was to Dannemora to connect with the Plattsburg and Dannemora line. Distance to Chateaugay was seventeen miles, an almost straight line, with an easy grade all the way. Distance to Dannemora was also seventeen miles, ten of which lay through solid wilderness. a crooked line running around two mountains and alternately

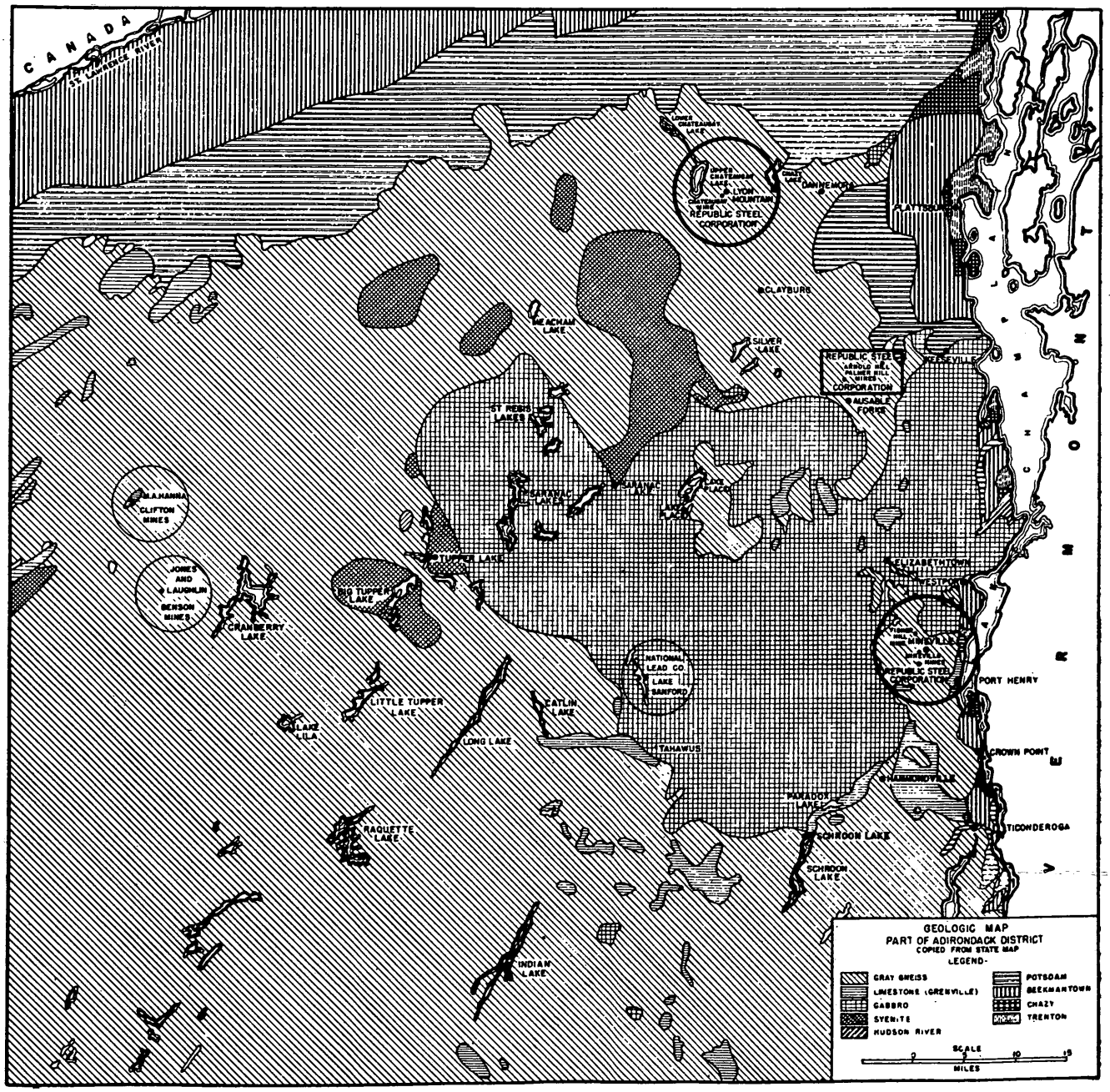
toward all points of the compass. But, because of the connection with the Delaware & Hudson R.R. and its access to the Pennsylvania steel centers, and at the same time because it provided an opening into Lake Champlain at Plattsburg, for water transportation, the latter route was adopted. On Dec. 18, 1879, ten months after the preliminary survey in 4 ft. of snow was commenced, the first train of ore was moved to Plattsburg.

Further development and production thereupon increased rapidly over the years. The mines and mills were soon producing concentrated ore for sixty forges in Clinton and Essex Counties. Lyon Mountain had grown from a few shacks in the wilderness to a thriving community of some 3000 inhabitants, the busiest spot in Clinton County.

In 1885, the Company began the erection of a blast furnace at Standish, four miles south, extending the railroad from Lyon Mountain to that point, and later to Loon Lake to reach the furnace, charcoal kilns, and woodlands that it owned. In the next year the Catalan forges at Standish were temporarily abandoned, and the making of pig iron commenced in the new blast furnace, using charcoal as fuel. This resulted in the development of an entirely new market, pig iron being an entirely different product from "bloom iron" produced by the Catalan forges. However, steelmaking by the Bessemer process was gaining by leaps and bounds in this country, and the Chateaugay iron, being extremely low in phosphorus, was in great demand. The village of Standish expanded and really began to make industrial history.

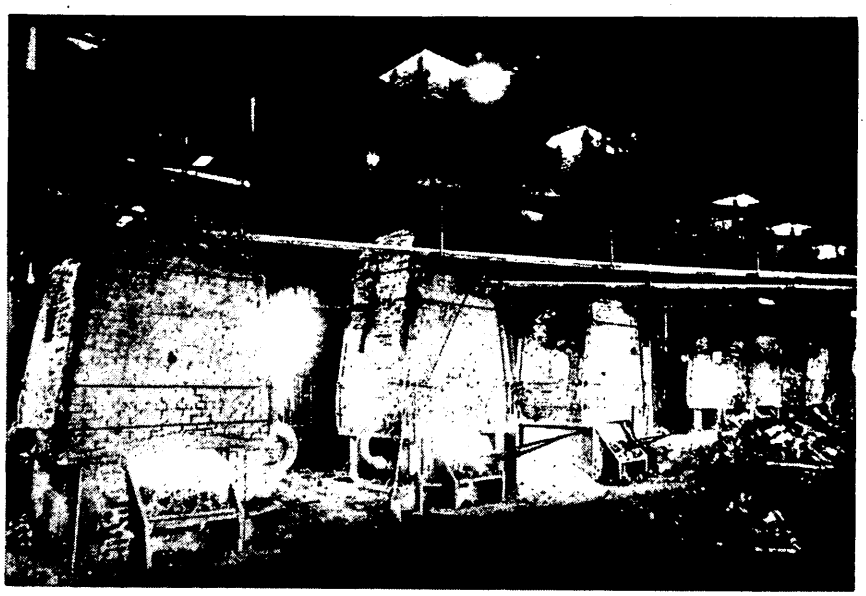
With the major depression of 1893, the Company moved the forges from Belmont to Standish, so that "bloom iron" and pig iron could be made at that one point and shipped by rail. When the revival of industrial activity began in the late '90's, a great demand arose for the ore as well as for the iron, and a comparatively new device for separating the ore came into use —the Ball & Norton magnetic separator. With this machine it was possible to make a concentrate running 60 per cent iron with a tailing of only 7 per cent iron, at the rate of ten tons per hour per machine. The separator at Lyon Mountain was enlarged, and a number of these machines installed, with good results.

As steelmaking by the Bessemer



Geological map of the country embraced in the present Adirondack iron mining development.

process, and the making of wrought iron by the puddling process, increased, demand for Catalan forge blooms decreased. This was not on account of quality, but because these new processes could make serviceable wrought iron and steel for less than half the cost of Catalan forge blooms. As a result, the American bloomery, which for many years had been the backbone of the iron and steel industry of the Adirondacks, was doomed. The Company subsequently abandoned its Catalan forge operations and continued making low-phosphorus pig iron in the blast furnace, using charcoal as fuel, and also continued to ship concentrate and lump ore from its mines at Lyon Mountain.



Catalan forges on Chateaugay Lake, 1880.

By now, it was obvious that the Chateaugay ore beds were most extensive, all of the ore being of the same character and purity. Because of the exceptional quality of the ore and the iron, the demand continued to increase, and it became evident that the property should be operated on a much larger scale.

About this time, the Delaware and Hudson Co. had a considerable financial interest in the Chateaugay Ore & Iron Co. and D. & H. President Willcox recommended to his board that they take over the Chateaugay company and operate it, which they authorized on July 29, 1903. The narrow-gage railroad, which meanwhile had been extended to Lake Placid, was promptly supplanted by a substantial, standard-gage railroad, with grades and curvature reduced. A large steam power plant was built, and two 500-kw. electric generators were installed to furnish power for the motors, which supplanted steam-driven engines at isolated points, and also for additional electromagnetic separators. Two air compressors were also installed, to ensure an ample supply of compressed air for drilling in the mine.

Because of the increasing difficulty of securing a sufficient supply of charcoal for the blast furnace and the fact that by this time coke had replaced charcoal in most of the blast furnaces in the country, and could be secured at a much lower cost, the Standish furnace was changed from a charcoal to a coke furnace.

Between 1903 and 1907 much of the light equipment was replaced with heavier and more substantial equipment. Output of ore and pig iron was considerably increased. In the years immediately preceding the first World War a well-defined study of the property was made, including a magnetometric and geological survey, diamond drilling, chemical analyses, and surveying and mapping the mine workings. The results revealed that the Chateaugay ore beds were tremendous in size, containing an almost endless supply of iron ore practically free from sulphur and phosphorus. So, in 1914, plans were made for the development of the ore body on a large scale, which included a new hoisting shaft, 1600 ft. deep, with steel headframe and modern electrically-driven hoisting equipment. War demands on production forced postponement of development work until 1919. The No. 1 shaft, which had been sunk to a depth of 900 ft., was then extended to a depth of 1685 ft., with four compartments; one for pipe and ladderways, one for men and supplies, and two for hoisting ore, all enclosed in steel and concrete. Levels and stopes were opened up, electric locomotives installed, and by 1924 all mining operations were confined to the new No. 1 shaft.

In 1921, a sintering plant was built at Lyon Mountain. In May 1924, the separator, which had been completed in 1918 of such material as was available, was destroyed by fire; a new and larger separator and concentrating plant, built entirely of steel and concrete, absolutely fireproof, was then built and put in operation in June 1925.

By 1925, the plants and equipment of the Company were modern in every way: including a well-developed mine, with one main hoisting shaft, with steel headframe and concrete and steel hoist house; a large and modern concentrating plant; and at the furnace, a skip hoist and bins, pig-casting machine, a 25,000-cu.ft. turboblower, a cooling system, and a revolving distributor. The subsequent years have been devoted entirely to operating the plant and marketing the products.

Early in 1939, Republic Steel, having taken over the Witherbee-Sherman mining operations at Mineville and Port Henry, looked with interest on the Chateaugay mining operations at Lyon Mountain. A study indicated that they would fit into the ultimate picture of Republic's proposed Adirondack development and the Delaware and Hudson Co. felt that it might be to their best interests to have their property operated by a steel company with large iron-ore consuming capacity, so a mutual agreement was readily consummated and Republic immediately decided to improve Chateaugay facilities for a decided increase in production. Demand for this special low-phosphorus ore, because of the war, resulted in doubling the output. Wet drilling and wet concentration have been adopted and installation of appropriate equipment is practically completed. In 1939, when Republic leased the property, the blast furnace at Standish was abandoned, and ore and sinter is now being shipped direct to the Company's blast furnaces at their various steel plants.

MacIntyre (National Lead)

ON the easterly side of the mountains following the Hudson River toward its source in Essex County, near Lake Sanford, lies a large body of titaniferous iron ore. Mt. Santanoni rises on the west, the Indian Pass yawns to the north, and Old Tahawus or Mt. Marcy, highest peak of the Adirondacks, towers on the east. Early in the last century, this was one of the busiest industrial spots in the Adirondacks. Its owners and operators at that time had great hopes of making it a world-renowned iron and steel producing center. However, despite bold initiative and enterprise, the undertaking failed a few years after the death of its guiding genius, David Henderson.

In 1826, a prospecting party visited the site of the deserted Elba iron works.

While they were looking about, an Indian approached one of them, David Henderson, showing him a piece of iron ore, and offered to guide the prospectors to the spot where he had found it. In the party, besides Henderson, were Duncan and Malcolm MacMartin, John MacIntyre, and Dyer Thompson. After two days' traveling they came to the spot where the river flows over the so-called natural iron dam, forming a ledge of ore that extended across the channel. Further investigation indicated that here was not only a seemingly inexhaustible supply of ore, but also boundless forests from which charcoal could be made, together with plenty of water for power. The only apparent drawbacks were the remoteness of the locality and the difficulties of transportation.

MacIntyre, Henderson, and MacMartin immediately proceeded to Albany where they arranged for the purchase from the State of a tract of land upon which lay this great deposit of iron ore. Organization of the Adirondack Iron Works followed. In 1839, it was incorporated as the Adirondack Iron and Steel Co. Archibald MacIntyre was the leader in this new enterprise, his associates being Judge MacMartin, Henderson, and Archibald Robertson of Philadelphia.

Because of the isolation of the country, developments were fraught with untold hardships. It was necessary to establish a road through the wilderness, from Lake Champlain to the operation; and without present-day tools and equipment such a task was a staggering undertaking. In fact, transportation was the most difficult problem to be solved. Over this crude road, much of which was built under the direction of these pioneers and at their own expense, a limited quantity of ore was drawn, in 1830, to Lake Champlain, fifty miles away, where tests indicated the satisfactory qualities of the iron. Meantime, members of the firm were working on the construction of primitive equipment, using a forge and charcoal to smelt the ore. In 1837 a puddling furnace was built and work carried on in preparation for making bar iron.

In 1838, Henderson was appointed principal manager of the firm, and a small blast furnace was constructed, with which he attempted to work out his idea of producing steel. Despite the severity of the winters, the difficulties of transportation, and the long time required to travel to the operation by boat, stage coach, buckboard, or on horseback, from New York or Albany, the enterprise grew and a village known as Adirondac was established, which, about 1850, numbered some 400 inhabitants and boasted of a church, a school, and at one time a private bank.

Under Henderson's direction the enterprise continued to grow. Unfortunately, however, that gentleman was accidentally killed in 1845 by the discharge of his own pistol, as he laid the weapon in its belt, on a rock. The decline of the enterprise really began with this accident, although the momentum which Henderson had imparted to the venture carried the development on for several years, so that the period from 1848 to 1854 was marked by the greatest activity.

A few years later a new and larger blast furnace was built, some little distance below the original structure. It was 36 ft. square, 48 ft. high, and was first put in operation in 1854. The lower part of this furnace still stands, and at the edge of the stream, close by, are the remains of the old cast-iron blowers, still in an excellent state of preservation. Of particular interest are the huge gears which operated them, these gears, in turn, being driven by water power from the near-by stream.

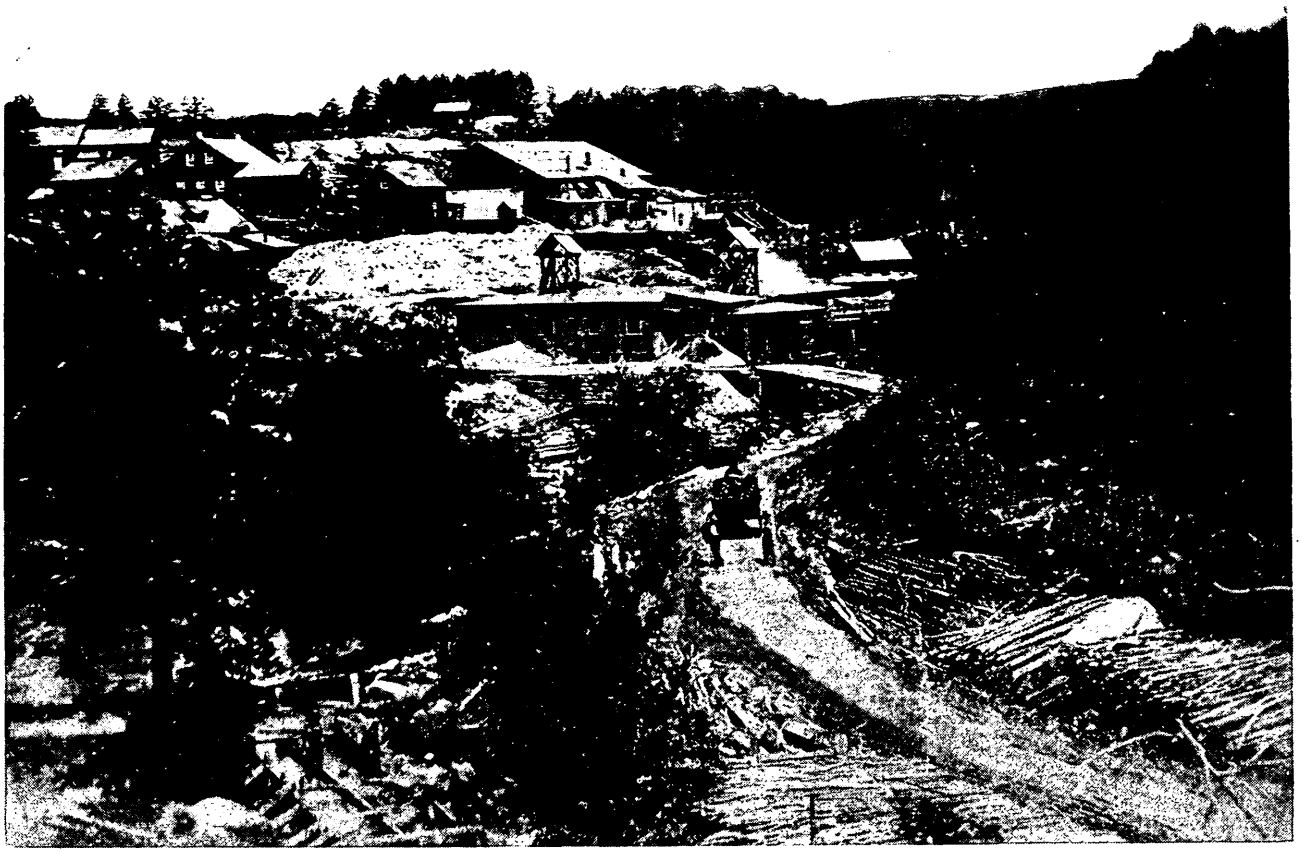
At this time the settlement of Adirondac boasted of a large boarding house, sixteen dwellings, a school house, a store, a carpenter shop, a blacksmith shop, a grist mill, a sawmill, a cupola furnace, a blast furnace, a forge and puddling furnace, and a stamping mill. In addition, a second village, named Tahawus, was established about ten miles down the river. Here a dam built across the Hudson River served to impound the waters into a sizable lake, over which the steel from the blast furnace above was transported on barges. This dam was destroyed by flood in 1856. At Tahawus, also referred to as the Lower Works, there was a dock and crane for handling the ore, a warehouse, a blacksmith shop, a sawmill, a boarding house, three dwellings, and a school. Of these, hardly a trace now remains.

Wallace T. Foote took control of the property in 1906 and under his direction activities were resumed. From 1906 to 1909, extensive investigations of the ore bodies, particularly the huge deposit on the west slope of Sanford Mountain, were conducted. New roads were opened, the possibilities of water power were investigated, a wide program of diamond drilling was carried out, and a railroad was again considered. Because of the acquisition by the State of much of the land surrounding the holdings of what had become known as the MacIntyre Iron Co., the routes previously considered were no longer available; wherefore, a new road from Sanford Mountain to Ticonderoga, a distance of some sixty miles, was surveyed and laid out, and in 1908, the Champlain and Sanford R.R. Co. was organized. Unfortunately, Mr. Foote was then taken ill and the development languished. He died in 1910 and the impetus that he had given to the venture passed with him.

However, in 1912-1913 it was decided that a test on a commercial scale employing modern methods of smelting should be conducted, in an attempt to determine whether or not these ores, with their titanium content, could be successfully utilized in the manufacture of steel. Accordingly a crushing and separating plant was erected on the eastern shore of Lake Sanford, in which was included a 7½-ton crusher. This crusher stood on the premises until 1939. A village was constructed, and roads were improved to facilitate the moving of the ore. In this venture, 15,000-25,000 tons of ore was reported taken out of an open cut, which is still in evidence. Part of this ore was crushed and concentrated on the premises, but as in previous days, this operation was handicapped by poor transportation, the severity of the winter climate, the unwillingness of laborers to work in such an isolated spot, and

Blast furnace blown in in 1854 by the MacIntyre Iron Co. at Tahawus. It is 48 ft. high and had a daily capacity of 14 long tons. It still stands in a remarkable state of preservation.

the difficulties of obtaining materials and supplies. The concentrate, as prepared at the mill, was taken out by sled trains which traveled from Sanford Lake to North Creek, their work at the close of the winter season being supplemented by teams and later by



Ore separating plant in the Adirondacks, early in the nineteenth century.

motor trucks. The ore thus secured was eventually transported by rail to Port Henry, where commercial tests were made in the plant of the Northern Iron Co. F. E. Bachman was in charge of the tests and his report, presented in 1914 at a meeting of the American Iron and Steel Institute, is an interesting document. Although the tests were considered successful, they do not appear to have promoted any commercial interest.

From this point on, no further activity occurred in the development of the MacIntyre ore bodies until recently when the possibilities of the titanium-bearing iron ore of this particular area were again studied.

The National Lead Co. opened negotiations with the MacIntyre Iron Co. for the purchase of their holdings of some 4000 acres in the town of Newcomb, upon which property two large beds of titaniferous iron ore were located—the Sanford Mountain deposit, on the east shore of Sanford Lake, and the Iron Mountain deposit, approximately 1½ miles to the northeast. Following an exhaustive title investigation, the National Lead Co. acquired the property on Sept. 20, 1941. Meanwhile, work was begun to develop the resources of this deposit, for the purpose of supplying a tonnage of ilmenite sufficient to guarantee the continued operation of the titanium pigment producing industry of the United States.

On Oct. 30, 1941, the National Lead Co. also took title to the entire holdings of Tahawus Purchase, Inc., and that portion of the property of the estate of Christine MacMartin Masten which surrounds and includes Lake Henderson. In all, nearly 7000 acres were so acquired. However, exclusive of approximately 550 acres located at the "Lower Works" or Tahawus, the property was leased back to the previous owners, now newly-organized as the Upper Works Club, for their continued and exclusive occupancy as a fish and game preserve.

On this ore bed a new program of core drilling was planned and executed beginning in May 1941. Over 11,000 ft. of diamond drill cores, taken out of seventy drill holes, proved the Sanford Hill deposit, above the lake level, to contain approximately 15,000,000 tons of ore analyzing 16 per cent of titanium dioxide. This should supply the titanium pigment industry of the United States for at least ten years.

Engineers of the National Lead Co. first visited the MacIntyre property on April 5, 1941. Plans formulated immediately afterward included construction of an adequate highway to the property, opening of a bench or open-pit mine, and construction and equipping of a concentrating plant with all necessary appurtenances. A firm of consulting engineers was chosen to design the mill and lay out the equipment, and their work started promptly following this initial visit. A little over two years later, on July 15, 1942, the new plant was completed and put into operation. Since then ilmenite concentrates have been flowing steadily to the paint industry and iron ore to the blast furnaces and steel plants, rounding out a long, interesting, romantic, important, and successful cycle of development.

Benson Mines (Jones & Laughlin Ore Co.)

TO the west, miles beyond the high peaks of the Adirondacks, is the Benson Mines ore deposit. It is in the town of Clifton, St. Lawrence County, on the north side of Little River, about 43 miles east of Carthage. Professor Emmons mentions the occurrence of magnetite bodies on this river near the crossing of the old abandoned military road, which was built between Albany and Ogdensburg during the War of 1812. Military engineers discovered the Benson deposits at the time of the construction of the road, because of the strong magnetic attraction on their compasses.

In 1886, the Magnetic Iron Ore Co., which was owned or controlled by the Benson family, developed and equipped a mining operation on a magnetite deposit at Jayville, fourteen miles west of what is now known as the Benson ore body. However, because these latter deposits were much larger, a railroad from Carthage to this location was extended in 1889, the Jayville operations were abandoned, and systematic mining and milling were commenced at the Benson Mines deposit.

Successful operations were continued until 1893, when they were closed down owing to the depression of that year. Mining was again resumed in 1900, but only for a short period. Subsequent to 1889, some 370,000 long tons of crude ore, or 150,000 long tons of milled concentrate of about 60 per cent iron is said to have been shipped.

With the Magnetic Iron Ore Co. succeeded by the Benson Mines Co., mining operations were resumed in the fall of 1907. August Heckscher was president, T. I. Crane, vice-president, and Robert K. Painter, manager. The mine was operated as an open-pit, using steam shovels. The crushing plant consisted of a jaw crusher and rolls. A dry concentrating plant, together with a two-kiln nodulizing plant with gas producers for firing the kilns, was constructed, and a hydroelectric plant was built at Brown's Falls on the Oswegatchie River a few miles away.

Operations were then practically continuous from 1907 until the spring of 1914, at which time a change was made in the operating management. W. D. B. Motter, Jr., was appointed manager, and under his direction a wet-concentrating pilot plant was installed. Results were so encouraging that the concentrating plant was rebuilt, changing from the dry process to the wet process, using ball-mill grinding and Grondal wet magnetic separators. A higher iron content in the concentrate resulted, together with a lower loss of iron in the tailing. The concentrate was nodulized in the kilns, resulting in an excellent, somewhat flaky, porous sinter.

A drawback of this operation was that the plant could not be run during the winter because it was entirely dependent upon its own power supply at Brown's Falls, and anchor ice interfered. So in the latter part of 1919 the power plant was sold to one of the large utilities which tied it into their transmission lines from other sources of supply but, because of its remote location and high production cost, and the falling off in the demand for iron ore after the end of World War I, the enterprise was abandoned late in 1919.

Benson Mines was again revived recently by the Jones & Laughlin Ore Co. of Pittsburgh (subsidiary of Jones & Laughlin Steel Corp.) whose geologists and mining engineers made an extensive and comprehensive exploratory and engineering study of its possibilities. Recommendations for the construction of a large concentrating plant and a sintering plant resulted.

Clifton Mines (Hanna Ore Co.)

IN the same neighborhood are the Clifton deposits, situated about ten miles north of the Benson Mines in an unsettled forest in the vicinity of the Grasse River. They were first opened in 1858. A charcoal furnace was built at Clarksboro by the falls on the Grasse River about three miles from the mines.

In 1868, the Clifton Mining Co., which then owned the property, erected a plant for manufacturing steel by a direct process. The mine at one time was connected with the Rome, Watertown & Ogdensburg R.R. near DeKalb Junction by a twenty-mile wooden railway. Operation of this property, although on a small scale, appears to have been successful for about twenty years and then, because of the many natural obstacles encountered by many another Adirondack iron mining venture of its day, it was gracefully abandoned.

The Clifton Ore Co., now the Hanna Ore Co., Clifton Mine Division (subsidiary of The M. A. Hanna Co., of Cleveland) acquired the property in 1941 and, after extensive diamond drilling, which proved to their satisfaction a rich magnetic iron ore deposit of many millions of tons, built a modern concentrating plant and a sintering plant at the mine site, arranged for the extension of a railroad to the plant from its previous terminus at Newton Falls, and began operations on a substantial basis. Ore for the present is secured from an open-pit but a vertical shaft is being sunk to intersect the vein about 500 ft. underground.

A GREAT many additional iron ore mining ventures in the Adirondack Mountains during the last century and a half are on record, nearly all of which were of considerable importance at the time. For the period of their existence, they served a useful purpose and gave livelihood and sustenance to a great many good, honest, persevering, and pioneering people, the kind of people who helped in their own way to build and develop these great United States. The fact that they often failed financially was no fault of theirs. They struggled, sacrificed both money and effort, and sometimes their health. No one except a person who has traversed these rugged mountains in the depth of winter, with temperatures as low as 50 degrees below zero and 90-mile gales laden with frosty snow, could have the slightest appreciation of the hardships these early pioneers endured. They received little in the way of compensation or comfort for their untiring efforts, but all those who have reverence for such people will be gratified to know that the fruits of their labor of prospecting, locating, uncovering, and opening up the many ore deposits in this vast wilderness have not been in vain. If it were not for this preliminary and pioneering work for which these good people received so little in return, it would have been impossible for the large mining concerns to open up many of these deposits so quickly and put them into successful operation, producing much-needed high-grade iron ore in behalf of this great war effort upon which our country depends so much.

Water wheel in Catalan forge plant, Chateaugay Lake, 1880.

tained quickly if examination of a drill shows they are needed. Closer supervision is possible here than underground, resulting in better work with less lost motion. The possibility of losing parts is also eliminated.

An overhead boom with an air hoist mounted on it enables the drill doctor to handle drills easily. A booth is provided with an exhaust fan where each drill is thoroughly cleaned with compressed air and cleaning fluid when it comes in for repairs, and before it goes back underground it is given a fresh coat of paint. A psychological advantage has been found in this; miners are inclined to handle a drill more carefully if it appears new when it goes back into service.

All furnaces are equipped with full metal hoods connected to an exhaust-pipe system. Suction provided by a blower removes all fumes and gases from the room. This feature, together with numerous safety devices, ensures the shop crew a clean, healthful place to work and thereby promotes efficiency.

Crushing, Concentrating and Sintering the Ore

To handle the increased production of iron ore resulting from the new development program in the mines, new concentrating facilities had to be built. Because of the silicosis hazard brought about by dry-milling and, further, because of the desire to eliminate as much of the phosphorus as possible from the ore, it was decided to go to wet concentration. With the mines located 1200 ft. above Lake Champlain and in a rather limited watershed, water supply for a wet mill presented quite a problem, so it was decided to do the primary and secondary crushing, with the elimination of as much rock as possible, at Mineville, and transport the crushed ore over an existing railroad to Port Henry, which is situated on the lake some seven miles from the mines. Here the ore, which had been crushed down to minus ¼ in., would receive its final concentration before shipment.

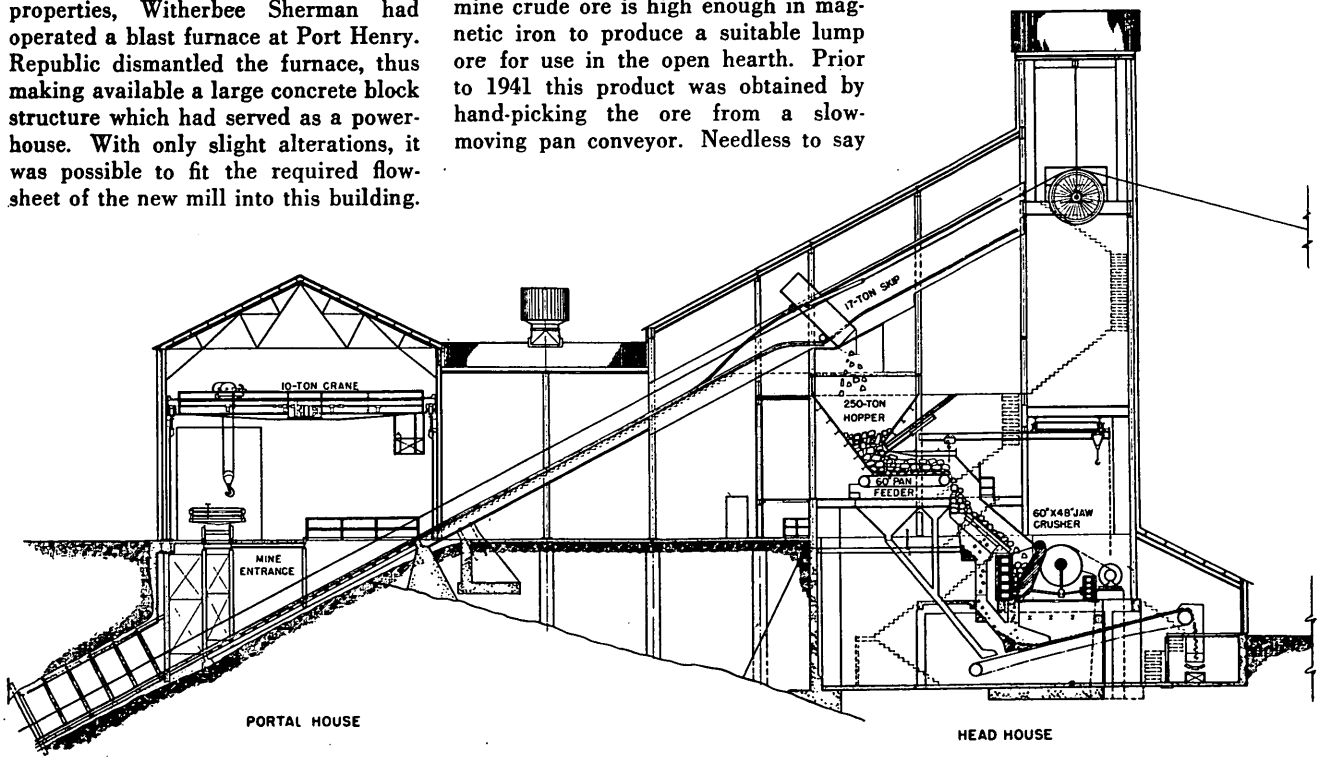
Prior to Republic's leasing of these properties, Witherbee Sherman had operated a blast furnace at Port Henry. Republic dismantled the furnace, thus making available a large concrete block structure which had served as a powerhouse. With only slight alterations, it was possible to fit the required flowsheet of the new mill into this building.

The primary and secondary crushing plants have a capacity of 300 long tons of crude ore per hour and are operated two eight-hour shifts per day. The concentrating plant has a capacity of 200 long tons of crushed ore per hour and is operated approximately 24 hours per day.

Crude ore, ranging in size from 36-in. cubes to fines, is dumped automatically from the mine skips into a bin holding approximately 250 long tons, the sloping sides of the bin being lined with rails to resist abrasion. From this bin the ore is fed by pan feeder over a stationary grizzly to a 48 by 60-in. jaw crusher discharging at minus 5½ in. The ore is then conveyed to two steel storage bins having a capacity of 1200 long tons each. Harmony ore goes directly from here to the secondary crushing plant, whereas the Old Bed ore is delivered to a lump-ore sorting plant.

About 25 per cent of the Old Bed mine crude ore is high enough in magnetic iron to produce a suitable lump ore for use in the open hearth. Prior to 1941 this product was obtained by hand-picking the ore from a slow-moving pan conveyor. Needless to say this was a costly operation and tied up a considerable number of men who could be used to better advantage, so it was decided to install magnetic pulleys to do this work. A two-surface screen and two 30-in. diameter by 36-in. face magnetic pulleys were accordingly installed. Ore is delivered from the primary crushing plant by belt conveyor and fed onto a double-deck vibrating screen—the top deck being covered with 3-in. wire cloth and the bottom deck with 1½-in. wire cloth. The plus-3-in. feed is delivered by gravity to one magnetic pulley, while the minus-3-in. plus-1½-in. is delivered to the other magnetic pulley. High-grade ore recovered by the magnetic pulleys is loaded directly into railroad cars for shipment. Lean ore rejected by the pulleys joins with the minus-1½-in. ore from the screen and is conveyed to the secondary crushing plant.

In the crushing plant two 5 by 12-ft. double-deck vibrating screens receive the ore and immediately make a three-part separation. The top deck of these units is covered by 1⅜-in.-opening square-mesh wire cloth, and the bottom deck by ¼-in. slotted wire cloth. The minus-¼-in. material drops by gravity to a 30-in. belt conveyor and is immediately delivered to crushed-ore storage bins. The plus-1⅜-in. material is delivered to a 7-ft. standard cone crusher while the minus-1⅜-in. is by-passed. This by-passed material and the crusher discharge are delivered to a 30-in. conveyor feeding two more 5 by 12-ft. double-deck vibrating screens.



Arrangement of head house and primary crushing plant at Mineville.

Fisher Hill Mine, Mill, and Sintering Plant

TREMENDOUS demands of the war program for iron ore required not only maximum production from present sources but also rapid development of other known deposits. Because of the already overtaxed shipping facilities of the Great Lakes, it was decided that ore bodies located on or near railroad facilities should be developed. Further, a rail haul would result in year-round availability of these ores for blast-furnace consumption.

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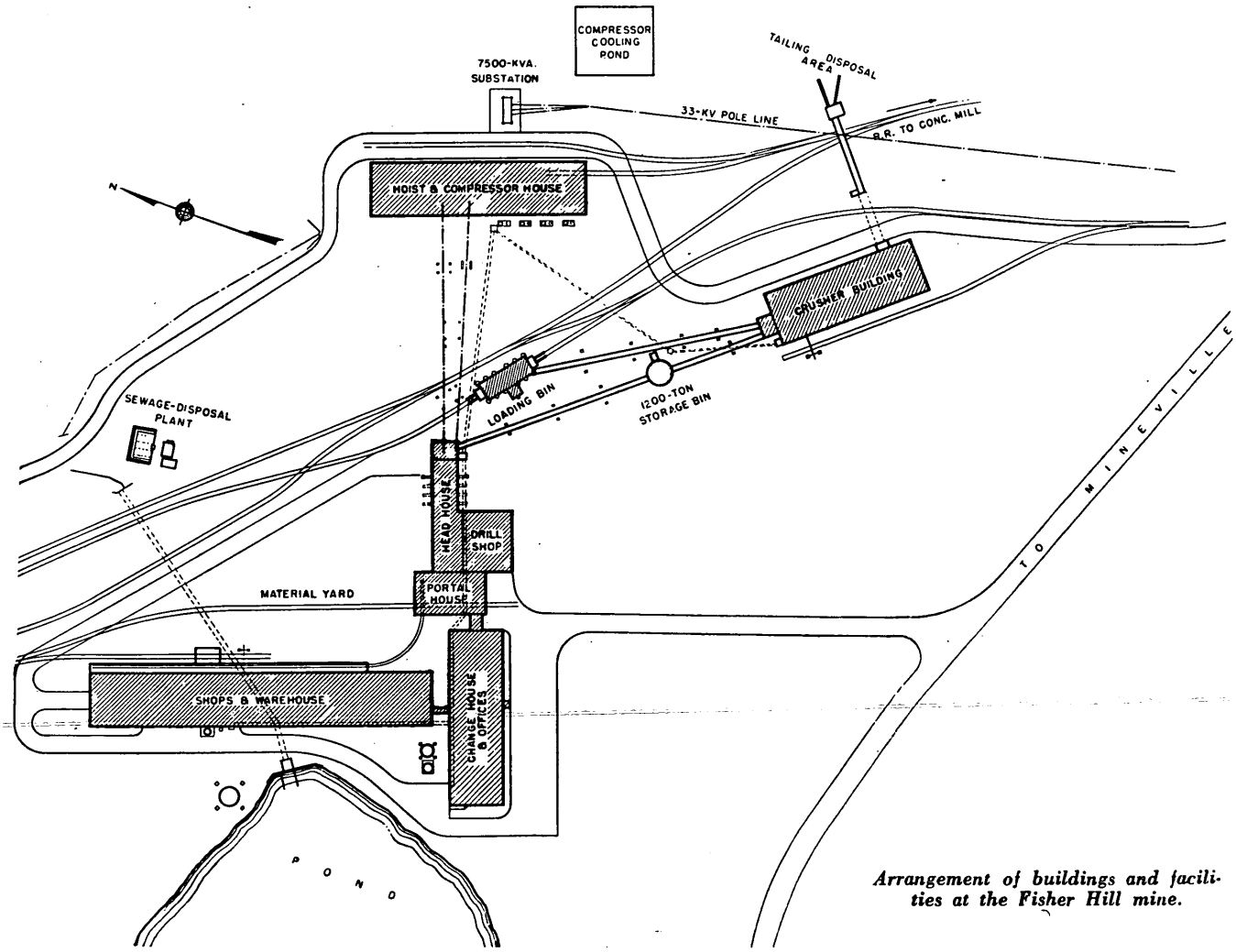
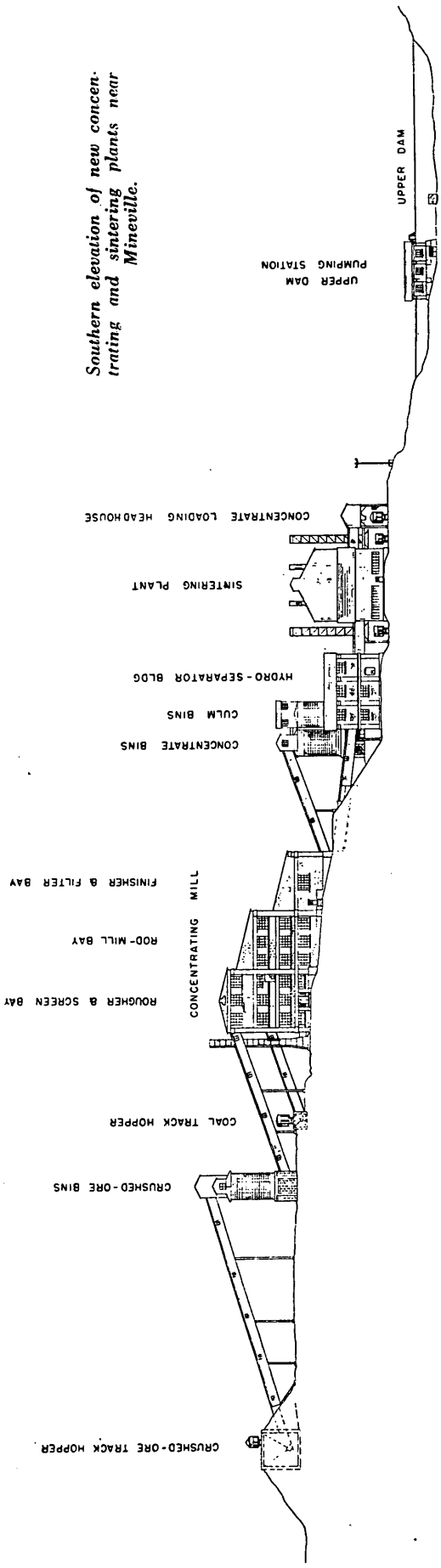
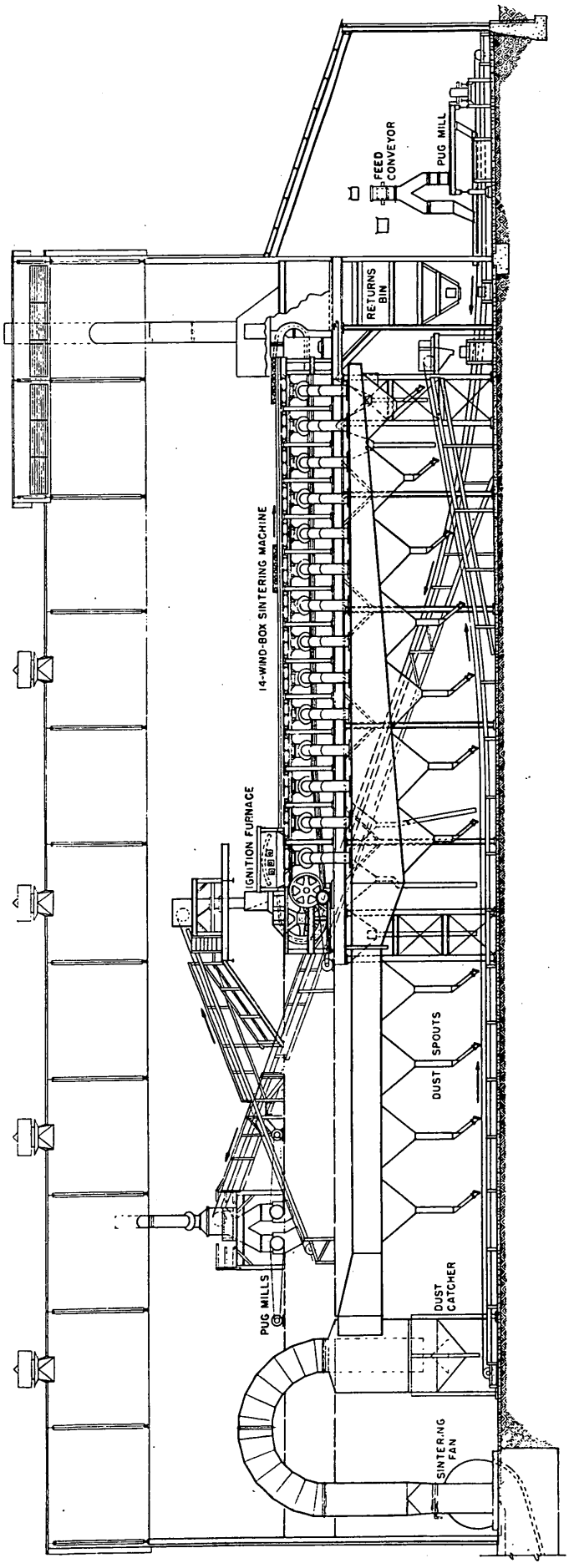


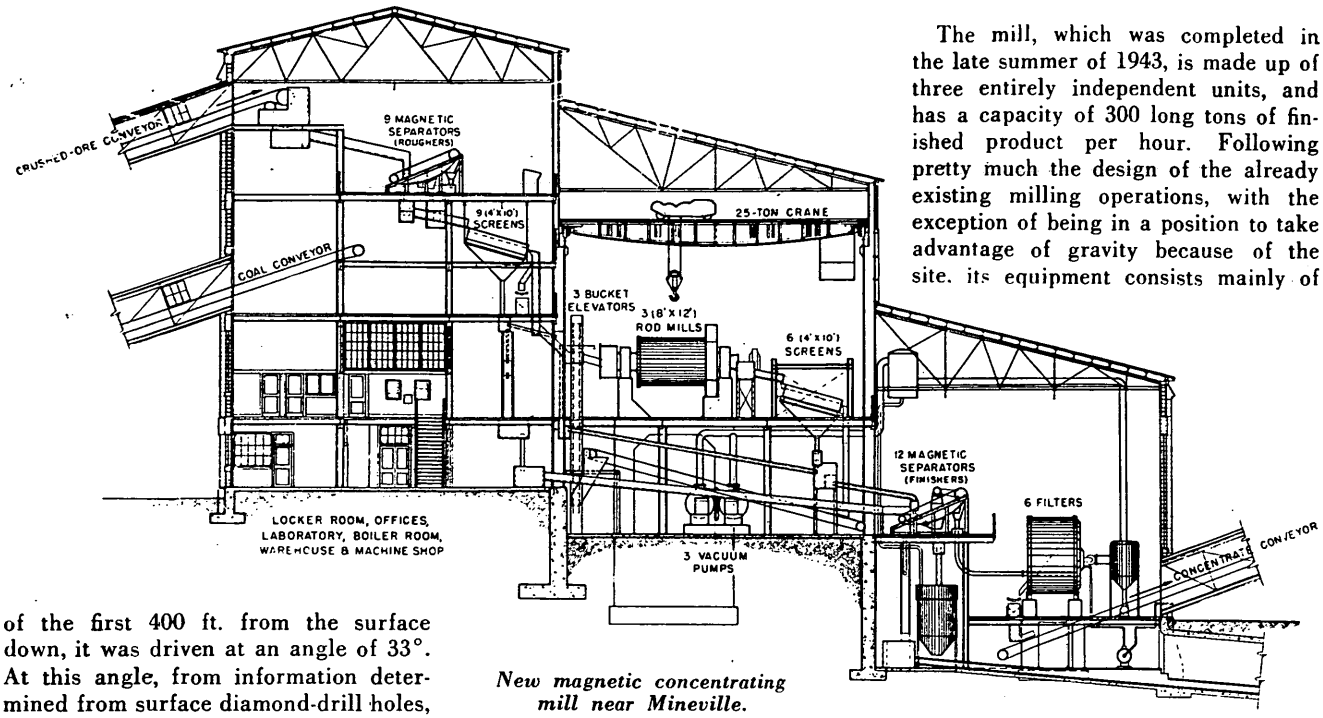
Arrangement of buildings and facilities at the Fisher Hill mine.



Southern elevation of new concentrating and sintering plants near Mineville.



Arrangement of sintering plant.



New magnetic concentrating mill near Mineville.

of the first 400 ft. from the surface down, it was driven at an angle of 33°. At this angle, from information determined from surface diamond-drill holes, it will remain in close contact with the ore body for a distance of at least 8000 ft. The upper part of the slope cut through an old excavation known as "Nigger pit," and to take advantage of this, the angle of the slope at this point is approximately 27°. Transition from the 27° angle to the 33° angle is accomplished by a large-radius vertical curve.

The slope is comprised of four compartments—two skipways in balance for handling the ore, a man and material skipway, and a concrete stairway and pipeway its entire length. Its construction is exactly the same as that of the main hoisting slope at the Mineville operations. When completed, the shaft will be 2000 ft. long, with five haulage levels and three pockets for handling the ore from tramcar to skip.

At Fisher Hill the slope and its hoisting equipment is designed to handle a little over 8000 long tons a day, which will be hoisted from loading pockets at three different elevations. The first-level ore will be handled from a point just below it. Ore from the second and third levels will be handled by means of ore-pass raises through a pocket above the fourth level; and the fourth and fifth level tonnage will be handled through a similar system—through a pocket just below the fifth level. All pockets are equipped with measuring chutes which will hold exactly one skip-load of ore.

The main ore hoist is a double drum, with both drums clutched, powered by two 1000-hp. d.c. motors. The hoisting rope is 1¾ in. in diameter and will handle 17 long tons of ore per skip.

All mining operations in the Fisher Hill ore body, because of its similarity in physical structure to the Mineville ore bodies, will be carried on under the same plan as that which is now in use in this district, and which has already been described, with slight modifications to meet local conditions. As the ore is delivered to the surface, it is also handled in pretty much the same manner as that of the Mineville ores, except that where larger tonnages are involved, equipment of larger capacity is used.

The change house, which connects directly to the entrance to the shaft, is modern in design. The warehouse and shops are also as close to the mine entrance as possible, to facilitate the transfer of repair parts and spares from these buildings into the mines.

Concentrator Close to Water Supply

IN picking the site for the new concentrating plant, the fact that it was to be a wet mill made water the most important problem. Experience in handling this extremely abrasive iron ore taught that handling ore by pumps was expensive and should be eliminated wherever possible. A site was thus chosen on the railroad line between Mineville and Port Henry where water could be obtained from the Bartlett Pond brook. As an auxiliary, a 16-in. steel pipe line was installed from a pumping station on Lake Champlain. By means of a hydro-separator, rake classifier, and a 200-ft. diameter thickener, three quarters of the water used could be reclaimed. The contour of the land is such that the crushed ore, from the time it enters the building until it leaves in the form of a finished product, flows from one unit to the next by gravity.

The mill, which was completed in the late summer of 1943, is made up of three entirely independent units, and has a capacity of 300 long tons of finished product per hour. Following pretty much the design of the already existing milling operations, with the exception of being in a position to take advantage of gravity because of the site, its equipment consists mainly of magnetic separators, vibrating screens, grinding mills, and filters. There is this exception, however, in that the magnetic separators used embodied improvements developed in this district. These machines, test units of which have been in operation on Harmony ore in the Port Henry mill for some two years, have greater capacity with a cleaner product, especially looking to the elimination of phosphorus, than any machine heretofore used here.

This new separator is made up of a heavy angle frame about 6 ft. wide and 10 ft. long, the top of which slopes at an angle of 30°. On either end and on top are mounted a head and tail pulley. An endless belt 54 in. wide and made up of 2-ply canvass with rubber covering is supported by the two pulleys. Between the head and tail pulleys and the upper and lower parts of the belt is mounted a magnet, 48 in. wide, consisting of twenty coils wired in four groups. For protection, these coils are enclosed in a stainless steel case filled with transformer oil. The magnet is connected in such a way that the current can be varied in any of the four groups. The underside of the belt travels in an upward direction toward the head pulley. Over the separator, and mounted to it directly ahead of the tail pulley, is a distributor which delivers the ore to a feedbox and pan mounted directly under the magnet. As the ore enters this feedbox it is washed up against the bottom belt, magnetic attraction holding the iron ore while the nonmagnetic material is carried away by gravity to a hopper directly underneath the tail pulley. As the ore is carried upward by the belt it passes over two spray pans, each with four

tained quickly if examination of a drill shows they are needed. Closer supervision is possible here than underground, resulting in better work with less lost motion. The possibility of losing parts is also eliminated.

An overhead boom with an air hoist mounted on it enables the drill doctor to handle drills easily. A booth is provided with an exhaust fan where each drill is thoroughly cleaned with compressed air and cleaning fluid when it comes in for repairs, and before it goes back underground it is given a fresh coat of paint. A psychological advantage has been found in this; miners are inclined to handle a drill more carefully if it appears new when it goes back into service.

All furnaces are equipped with full metal hoods connected to an exhaust-pipe system. Suction provided by a blower removes all fumes and gases from the room. This feature, together with numerous safety devices, ensures the shop crew a clean, healthful place to work and thereby promotes efficiency.

Crushing, Concentrating and Sintering the Ore

To handle the increased production of iron ore resulting from the new development program in the mines, new concentrating facilities had to be built. Because of the silicosis hazard brought about by dry-milling and, further, because of the desire to eliminate as much of the phosphorus as possible from the ore, it was decided to go to wet concentration. With the mines located 1200 ft. above Lake Champlain and in a rather limited watershed, water supply for a wet mill presented quite a problem, so it was decided to do the primary and secondary crushing, with the elimination of as much rock as possible, at Mineville, and transport the crushed ore over an existing railroad to Port Henry, which is situated on the lake some seven miles from the mines. Here the ore, which had been crushed down to minus ¼ in., would receive its final concentration before shipment.

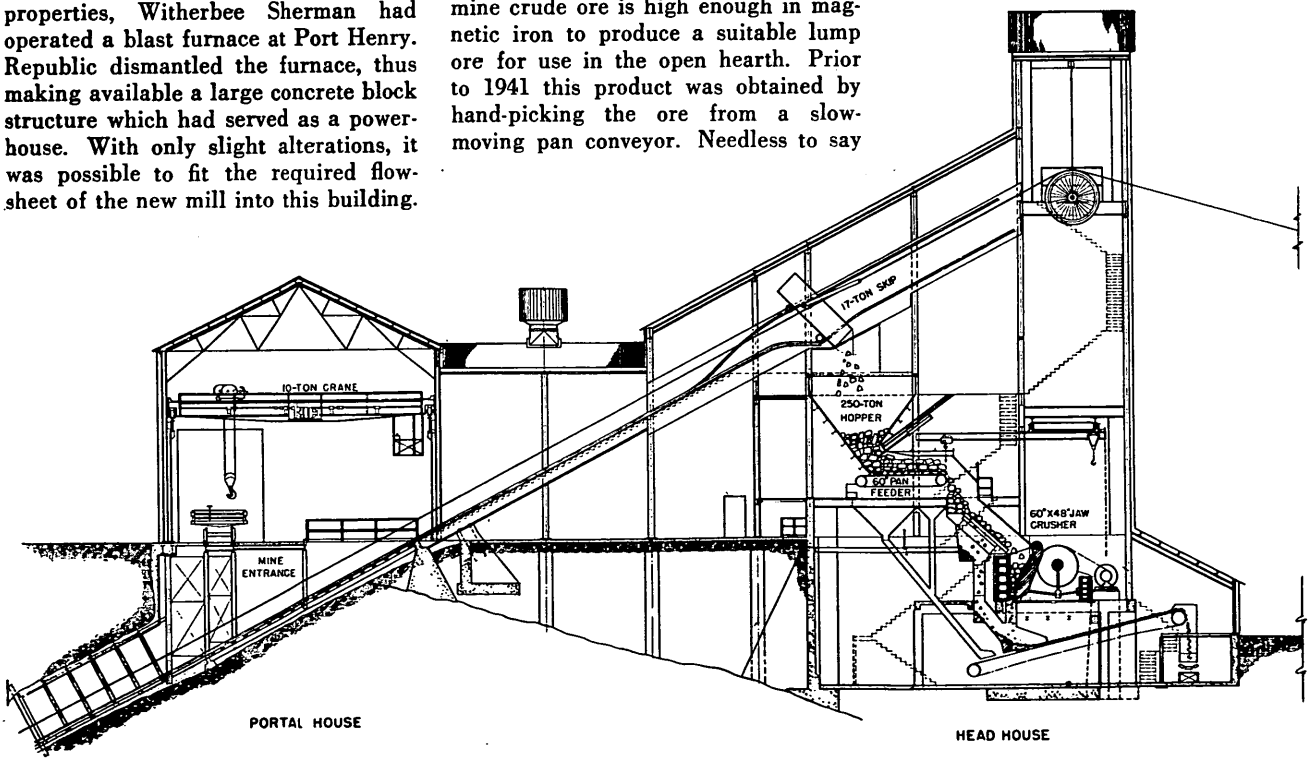
Prior to Republic's leasing of these properties, Witherbee Sherman had operated a blast furnace at Port Henry. Republic dismantled the furnace, thus making available a large concrete block structure which had served as a powerhouse. With only slight alterations, it was possible to fit the required flowsheet of the new mill into this building.

The primary and secondary crushing plants have a capacity of 300 long tons of crude ore per hour and are operated two eight-hour shifts per day. The concentrating plant has a capacity of 200 long tons of crushed ore per hour and is operated approximately 24 hours per day.

Crude ore, ranging in size from 36-in. cubes to fines, is dumped automatically from the mine skips into a bin holding approximately 250 long tons, the sloping sides of the bin being lined with rails to resist abrasion. From this bin the ore is fed by pan feeder over a stationary grizzly to a 48 by 60-in. jaw crusher discharging at minus 5½ in. The ore is then conveyed to two steel storage bins having a capacity of 1200 long tons each. Harmony ore goes directly from here to the secondary crushing plant, whereas the Old Bed ore is delivered to a lump-ore sorting plant.

About 25 per cent of the Old Bed mine crude ore is high enough in magnetic iron to produce a suitable lump ore for use in the open hearth. Prior to 1941 this product was obtained by hand-picking the ore from a slow-moving pan conveyor. Needless to say this was a costly operation and tied up a considerable number of men who could be used to better advantage, so it was decided to install magnetic pulleys to do this work. A two-surface screen and two 30-in. diameter by 36-in. face magnetic pulleys were accordingly installed. Ore is delivered from the primary crushing plant by belt conveyor and fed onto a double-deck vibrating screen—the top deck being covered with 3-in. wire cloth and the bottom deck with 1½-in. wire cloth. The plus-3-in. feed is delivered by gravity to one magnetic pulley, while the minus-3-in. plus-1½-in. is delivered to the other magnetic pulley. High-grade ore recovered by the magnetic pulleys is loaded directly into railroad cars for shipment. Lean ore rejected by the pulleys joins with the minus-1½-in. ore from the screen and is conveyed to the secondary crushing plant.

In the crushing plant two 5 by 12-ft. double-deck vibrating screens receive the ore and immediately make a three-part separation. The top deck of these units is covered by 1⅜-in.-opening square-mesh wire cloth, and the bottom deck by ¼-in. slotted wire cloth. The minus-¼-in. material drops by gravity to a 30-in. belt conveyor and is immediately delivered to crushed-ore storage bins. The plus-1⅜-in. material is delivered to a 7-ft. standard cone crusher while the minus-1⅜-in. is by-passed. This by-passed material and the crusher discharge are delivered to a 30-in. conveyor feeding two more 5 by 12-ft. double-deck vibrating screens.



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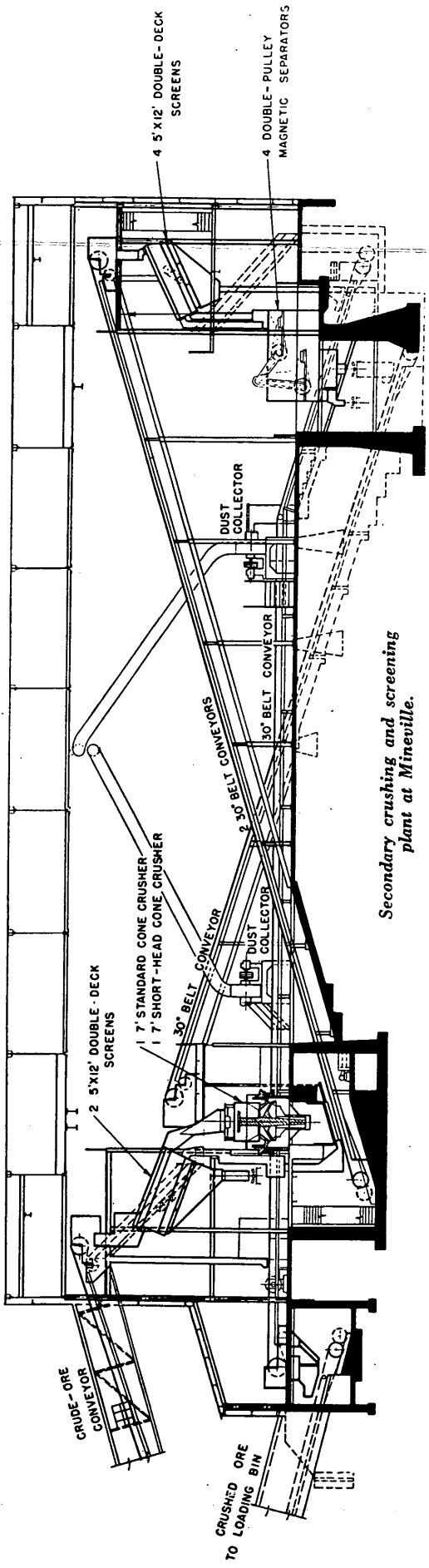


Secondary crushing and screening plant at Mineville.

The top deck of these units is covered with ⅝-in.-square-opening wire cloth and the bottom deck with ¼-in. slotted cloth. The minus-¼-in. ore is delivered by gravity to the same conveyor handling the minus-¼-in. product from the No. 1 screens and conveyed to the crushed-ore storage bins. The minus-⅝-in. plus-¼-in. material is delivered to a double-pulley-type magnetic cobbing machine, while the minus-1⅜-in. plus-⅝-in. material is delivered to a second magnetic cobbing machine. The degree of separation on these units is controlled by the intensity of current carried in the magnetic pulley and the position of a division board at the point of discharge. Material containing less than 3 per cent magnetic iron is thrown off by centrifugal force, while the ore is carried by the belt around one half of the circumference of the pulley and released when the belt carries it out of the magnetic field. The rock or tailing is carried by conveyor belt to disposal. The ore is delivered to a closed circuit consisting of a 7-ft. short-head cone crusher, 5 by 12-ft. vibrating screens, and magnetic cobbing machines where it remains until thrown out as rock or ground down so that it passes through the ¼-in. screens. The rock, of course, is conveyed to disposal, and the minus-¼-in. material is delivered to the crushed-ore storage bins.

Concentrating to 68-69 Per Cent

THE concentrating mill, located on the lake at Port Henry, consists of two absolutely independent units. Ore, delivered in railroad cars, is discharged by gravity into either one of two sets of bins—one for Harmony and one for Old Bed. From these bins it is fed by belt conveyor to high-intensity wet magnetic separators, of which there are two for each unit. These separators are known as roughers and their function is simply to eliminate immediately as much free gangue as possible. The gangue, or tailing, flows by gravity to an 8-in. pump and is discharged through a rubber-lined steel pipe to the waste pile. The magnetite-bearing material then passes over a 4 by 12-ft. vibrating screen covered by 10-mesh slotted screen cloth. Oversize is carried to an 8 by 8-ft. ball mill grinding to minus 10 mesh. It then joins the undersize from the vibrating screen and flows through launders to a second set of four high-intensity wet magnetic separators called finishers. Here a clean tailing and a high-grade magnetic concentrate is produced. The tailing joins with the rougher reject for disposal, while the concentrate is dewatered by two 5 by 10-ft. inside-drum filters. This concentrate is elevated to storage bins for delivery to the sintering plant as required.

When treating 4800 long tons of crushed ore daily, the mill will produce approximately 3000 long tons of concentrate, averaging from 68 to 69 per cent iron. In the Harmony ore, with the newly improved wet magnetic separator, the phosphorus will be reduced to 0.025 per cent, and in the Old Bed to 0.25 per cent. With Lake Champlain acting as a tremendous reservoir, water is no problem and, because the mill is also on the main line of the Delaware & Hudson R.R., no further rehandling of either the concentrate or the sintered ore is necessary before shipment direct to Republic's steel plants at Buffalo, Cleveland, Youngstown, or Warren. The plant will handle economically the projected production of the Harmony and Old Bed mines.

Sintering the Concentrate

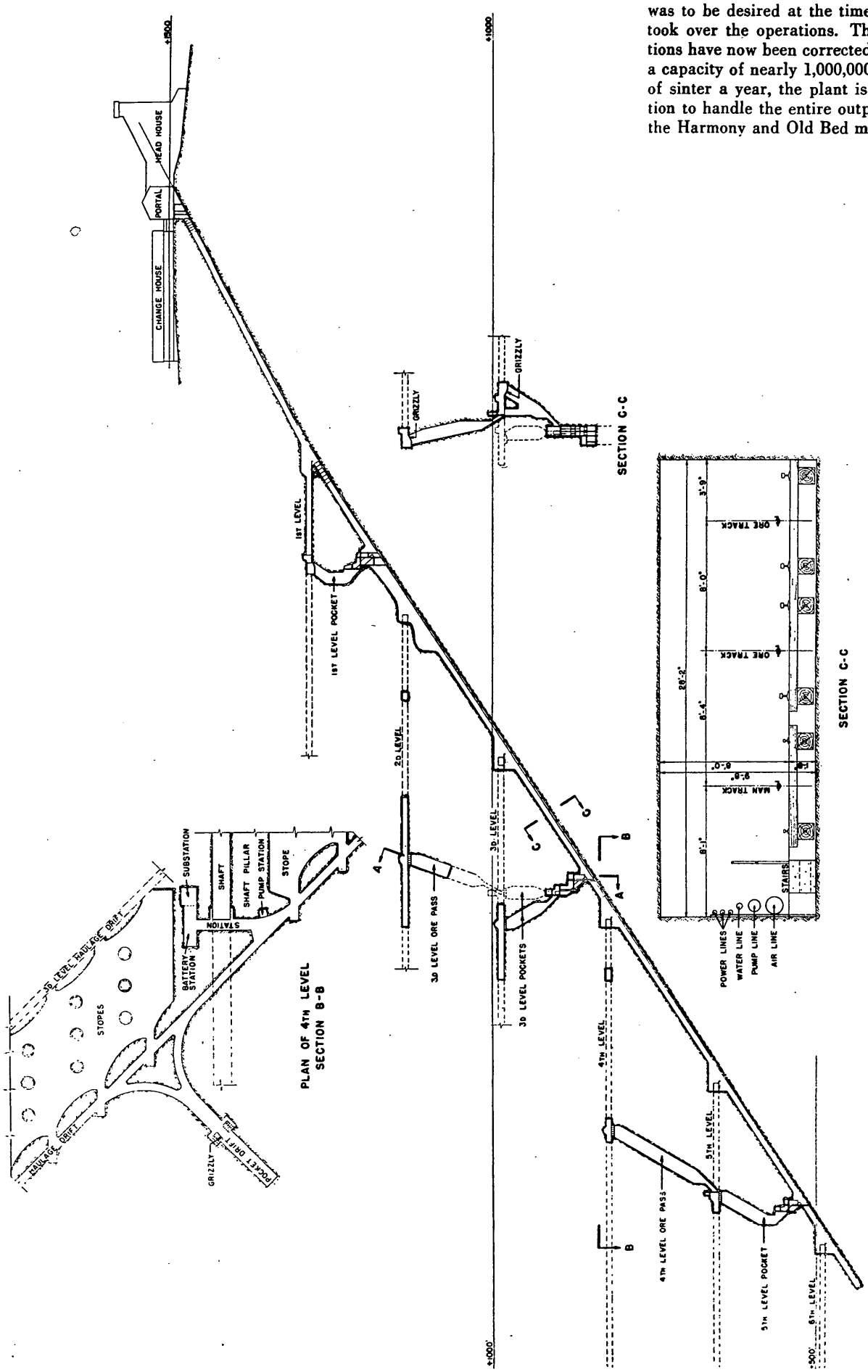
IN grinding Adirondack magnetites for high-grade concentration, the resulting product from a physical standpoint is not desirable for use either in the blast furnace or open hearth. Therefore, sintering or fusing of the fine magnetic material into a porous mass is an important part of these operations.

The sintering plant, of the intermittent type, is adjacent to the concentrating plant at Port Henry, and is made up of five 10 by 24-ft. pans. These pans, although under the same roof, make up two distinct units of three and two pans each—one unit handles Old Bed concentrate, while the other unit handles Harmony. A charge car and ignition car is provided for each group. Suction for the burning process is produced by fans—one for each pan. Briefly the process consists of mixing approximately 5 per cent (by weight) of fine anthracite culm with the concentrate. To the mixture of concentrate and culm is added return fines, produced by discharging the sintered product over a stationary grizzly having openings of ¾ in. The amount of return fines in this mixture is 25 to 30 per cent. This charge is then fed to a pug mill where it is thoroughly mixed, water being added as a temporary binder so that the feed will remain fixed as it is spread on the pans.

After spreading this feed evenly, to a thickness of anywhere from 8 to 11 in., the bed is thoroughly ignited by low-pressure fuel-oil burners. The sintering time varies according to the thickness of the bed and at these operations is from seventeen to twenty minutes. The finished product, after screening out the fines, is discharged directly into railroad cars.

Each pan handling minus-10-mesh Old Bed and Harmony concentrates has a conservative capacity of 25 long tons per hour. From a mechanical standpoint, due to the age of the plant, much

was to be desired at the time Republic took over the operations. These conditions have now been corrected and, with a capacity of nearly 1,000,000 long tons of sinter a year, the plant is in a position to handle the entire output of both the Harmony and Old Bed mines.



Section through shaft at the Fisher Hill mine.

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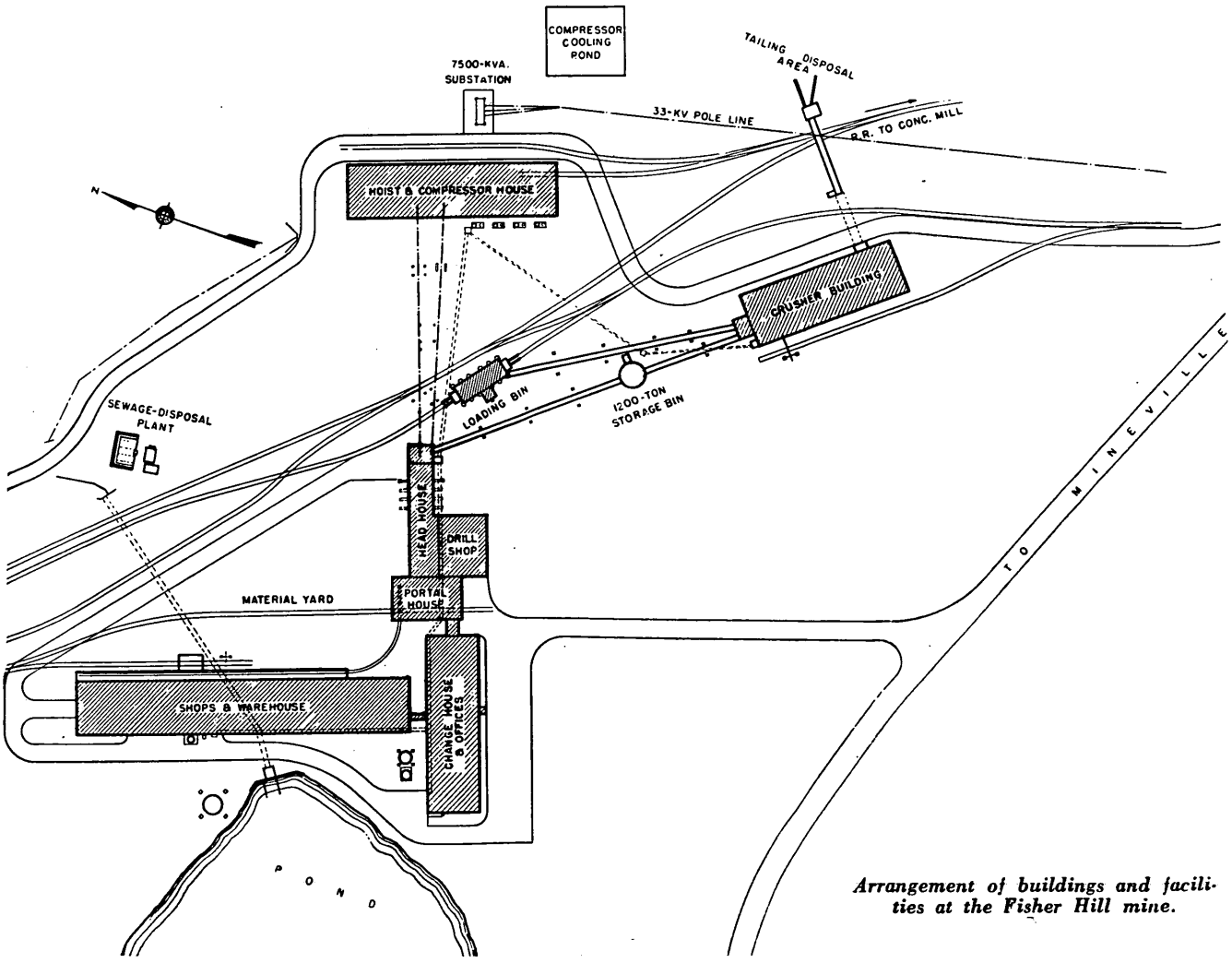
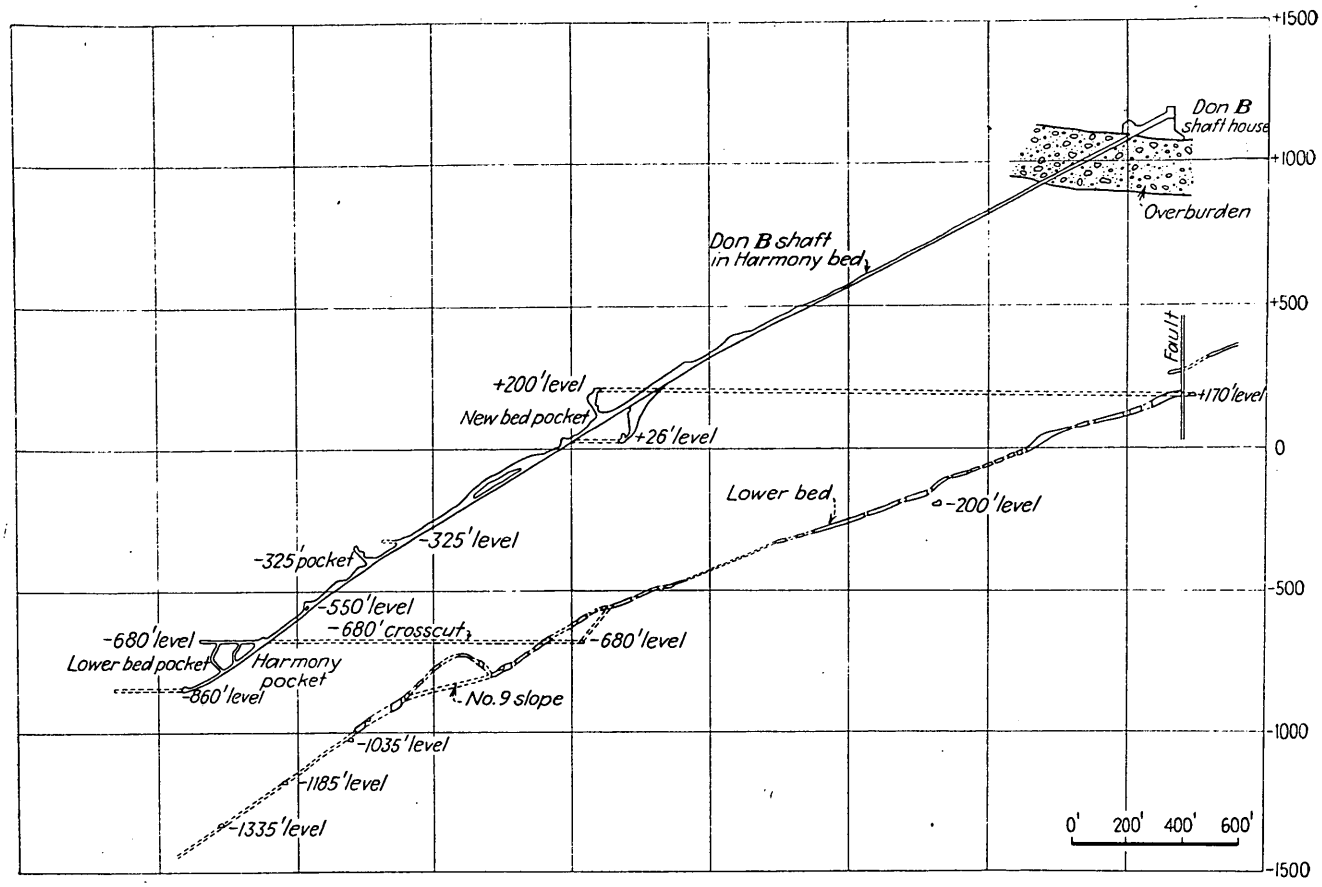


Arrangement of buildings and facilities at the Fisher Hill mine.



Section through Don B shaft, showing Harmony and Lower beds.

sinking operations a steel headframe which also serves as the primary crushing house was erected. A new hoist house was provided and, because of long-term delivery on equipment, decision was made to transfer a hoist from one of Republic's properties in Michigan. The hoist, which will wind approximately 5000 ft. of 1⅜-in. cable, will handle 12 long tons of ore in balance. When the old stoping area was reached, in order to cut and fill as little as possible over the extremely irregular footwall, three vertical curves of large radius were laid out. The line of the old slope was not exactly straight so it was necessary to remove some pillars completely. However, the granitic gneiss hanging wall of the Harmony ore body was strong enough to permit completion of the new shaft through these old areas with little auxiliary support.

The roadbed of the new shaft is provided with concrete piers at 20-ft. intervals across the entire width of the shaft. Four 12 by 12-in. creosoted longleaf yellow pine timbers are placed between these piers, one directly under the line of each rail. Creosoted 6 by 8-in. by 15-ft. ties are laid across these timbers and the 112-lb. rails with tie plates are placed on the ties. Every fifth tie is bolted to the stringers and anticreepers are installed every third pier. Coarse rock tailing was used for ballast to ensure proper drainage in wet places.

Level stations were constructed of steel and concrete at the +200-ft., the +26-ft., the —550-ft., and the —680-ft. levels, and loading pockets for handling the present Harmony production were constructed at the +200 and —680 levels. (Levels are indicated by their altitude, with Lake Champlain as a datum.) At present the lowest working level of the Harmony ore body is the —680. At this elevation a 1000-ft. rock crosscut connects the Harmony and Old Bed veins and inasmuch as the bulk of the future Old Bed production was to come from below this elevation it was decided to establish the Old Bed ore transfer at this point.

Old No. 9 Slope in the Old Bed vein was reconditioned by grading and the installation of 48-in.-gauge track, using 60-lb. rail and creosoted ties. A reconditioned electric hoist, equipped with modern electrical control, is installed at the head of the slope; and all mining level stations off the slope are constructed of steel and concrete. A sinking program has been started with mining levels laid out at 300-ft. intervals.

Old Bed ore from this slope is discharged into a steel pocket on the —680-ft. level where it is loaded by gravity into trains of 10-ton mine cars which are hauled by a trolley locomotive to a pocket on the new slope in the Harmony mine. From this point it is hoisted approximately 3600 ft. to the surface. This is the only trolley locomotive haulage system in the mines, all other locomotives being of the storage-battery type. This change eliminates the hazard of 250-volt trolley wire throughout the mine, especially at the loading chutes and platforms where the men are forced to use steel bars from time to time. In the past, several bad accidents resulted when a steel bar came in contact with the trolley wire.

At present only two pockets are available from which to hoist on No. 9 Slope—the 1035 pocket and the combined 1185 and 1335 pocket. This second pocket is just below the 1335 level at elevation —1390 and will handle the ore through an ore-pass raise between the 1335 and 1185 levels. The distance from this pocket to the dump above the —680 level is 1618 ft. The skips on No. 9 Slope are equipped with roller-bearing wheels and have a capacity of 6 long tons.

In all new work the levels have a vertical interval of 150 ft., which, at the general average dip of 30°, gives an inclined interval of 300 ft. This keeps the scraping distance within what is considered an economical limit at these operations. The 150-ft. vertical interval also fits in well with the gravity ore found in the big folds in the Old Bed mine, in that a modified sublevel bench stoping method can be employed.

Compressed air for the mines is furnished by a central power plant on the surface and piped through a 12-in. line

at 100-lb. pressure. At each level a 4-in. line is taken off for distribution along the main drifts. From these, 2-in. pipe lines feed air to the various stopes and working places. Water for use on the rock drills is distributed in much the same manner. Electric power is delivered to the mine at 33,000 volts and transformed to 2300 volts for delivery underground. Here the voltage is further reduced to 440 and 110 volts.

Development and Stoping Operations

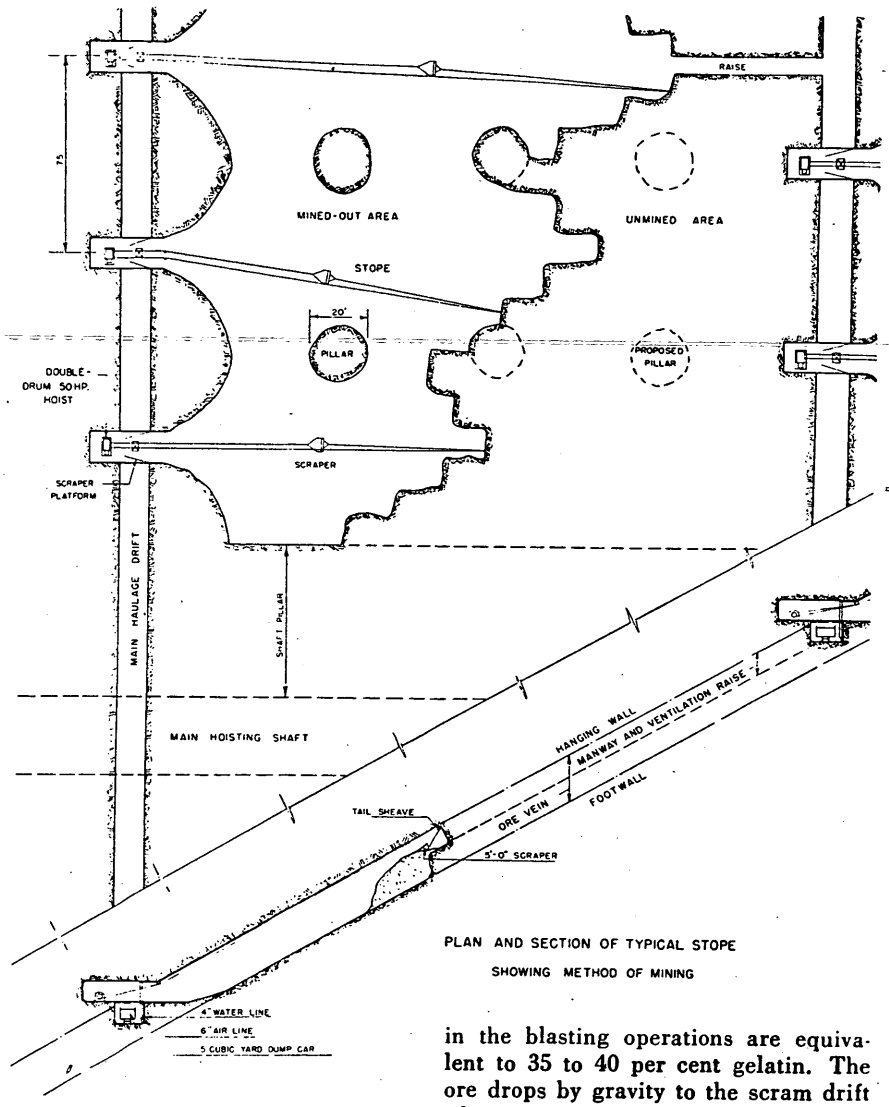
ALL main levels are 9 ft. high by 12 ft. wide and are driven on a plus ¾ of 1 per cent grade, favoring the loaded trains and permitting the drainage of all water by gravity to central sumps near the main slope. Drifts are equipped with 36-in.-gauge track with 60-lb. rail laid on hardwood ties spaced from 24 to 30 in. apart. The track is ballasted with fine iron ore or rock, depending on the material through which the drift is being driven.

When drifting in the flat-lying ore body, overbreaks are shot in the roof every 75 ft. From this overbreak two 8 by 12-ft. rounds are driven back horizontally into the hanging. This excavation allows the construction of a suitable loading platform and the installation of a 50-hp. electrically-driven double-drum scraper hoist. This type of hoist will wind 350 ft. of ¾-in. steel cable and 700 ft. of ⅝-in. steel cable. A hoe-type scraper with manganese steel backplate is attached to the ropes for handling the ore coming from development and subsequent mining at this location. 6 by 8-ft. raises are then driven up in the hanging side of the ore body for a distance of approximately 40 ft. The stope is now ready for mining. From every third opening a 6 by 8-ft. raise is driven through to the level above, following the ore body along the hanging wall. This raise is used for both mining and ventilation. Air and water lines are piped down from the top of the raise. In this way the pipe lines are always in the clear of mining and blasting operations. This also allows the drillers to retreat up along the ore body and away from the large opening resulting as mining progresses. The location of these raises on each level is staggered so that holing through from one level to another can be accomplished without interfering with any of the stoping operations on the level above.

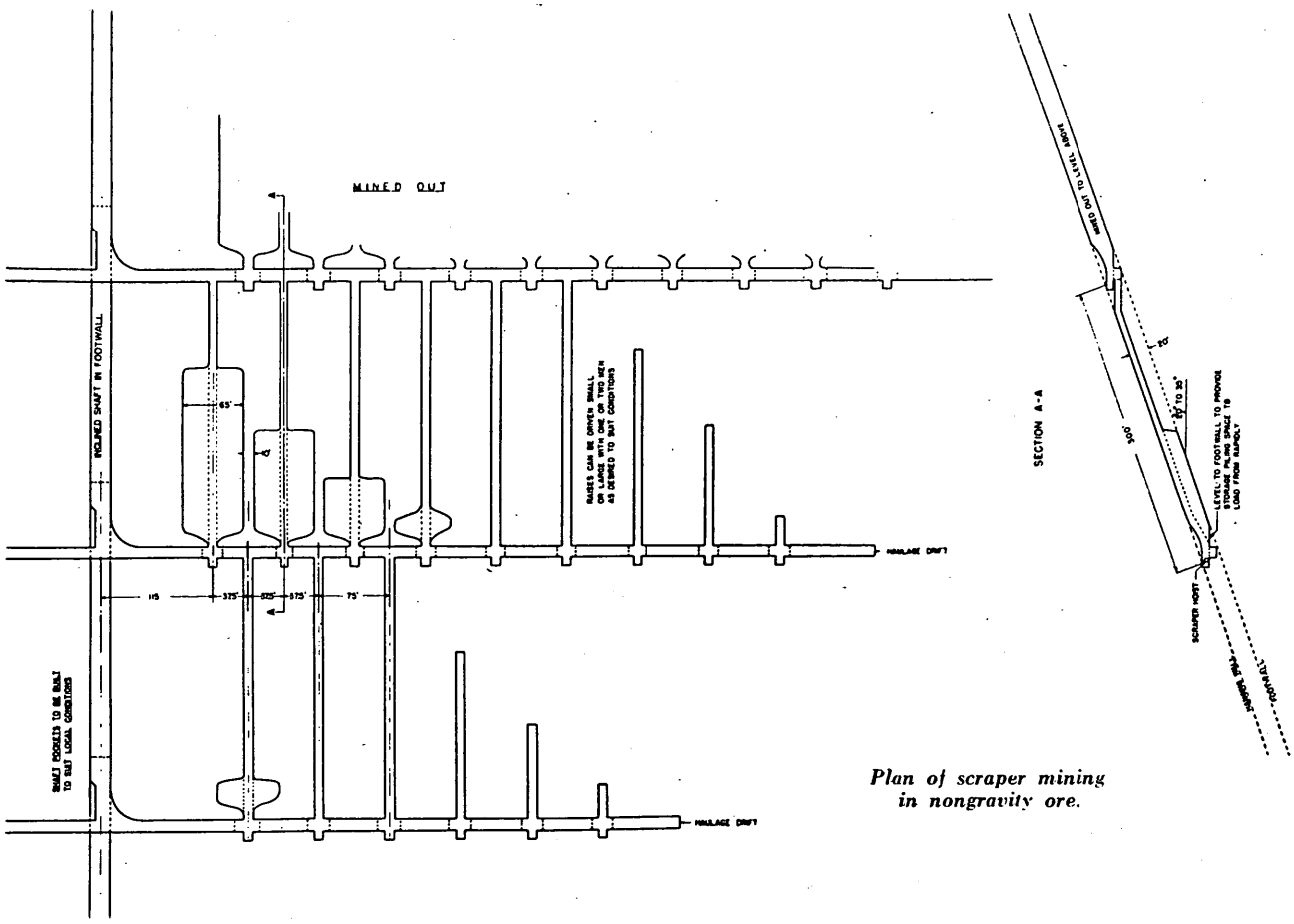
This method of mining is used exclusively in the Harmony and New Bed mines and will be used in the Fisher Hill mine. In the Old Bed mine the flat ore bodies are mined by the same method, though in the big folds a considerable quantity of ore is steep enough to be stoped by gravity. The axis of these folds pitches downward at an angle of about 30°. Along the axis of the steep part of the fold, and 8 ft. above the floor of the main haulage drift, a scram drift 8 by 12 ft. wide is driven along the strike of the ore body. From this scram drift raises on 45-ft. centers are driven up into the ore and a raise on one end of this block of ore is driven through to the level above. From this raise 5 by 7-ft. subdrifts are driven in the ore body above and parallel to the scram drift. These sublevels are spaced at such a distance between the levels that a 30-ft. floor pillar is left to protect the haulage level above. The raise serves as a manway and means for piping air and water for stoping operations. At the extreme end of the sublevel the raise from the scram drift is driven up and breaks into the sublevel. The opening is then enlarged and mining operations begun.

Mounted jackhammers are used for slabbing from foot to hanging and hand-held jackhammers are used for drilling the benches. Explosives used in the blasting operations are equivalent to 35 to 40 per cent gelatin. The ore drops by gravity to the scram drift where it is loaded by a scraper hoist into 10-ton Granby-type tramcars. As mining operations progress the drillers retreat toward the manway raise, carrying the benches down and breaking into the successive short raises which have been driven from the scram drift. Using this method, our workmen are never exposed to the hazards of large open areas. Because of the inherent silicosis hazard, all drilling is done wet. All drills are equipped with the approved New York State backhead, constructed so that as the air is turned on the machine a water valve is automatically opened, ensuring water at all times in the drilling operations.

The scram or slushing drift method of loading ore from these gravity stopes was applied here after unsuccessful experiments with timber chutes from which the ore was loaded directly into the cars without rehandling. Due to the heavy and blocky abrasive ore, an excessive amount of repair work was necessary to keep the chutes in working order. Also large chunks of ore would clog the chute, making it necessary to do a lot of barring and in some cases blasting. Several serious accidents re-



PLAN AND SECTION OF TYPICAL STOPE SHOWING METHOD OF MINING



Plan of scraper mining in nongravity ore.

sulted. With the scram drift, the stope raises are located so that the angle of repose of the muck will never allow the drift to be filled more than half way. Any secondary blasting required on large chunks can be done safely, with the miner working on top of the muck pile instead of from below as he did when using the timber chutes.

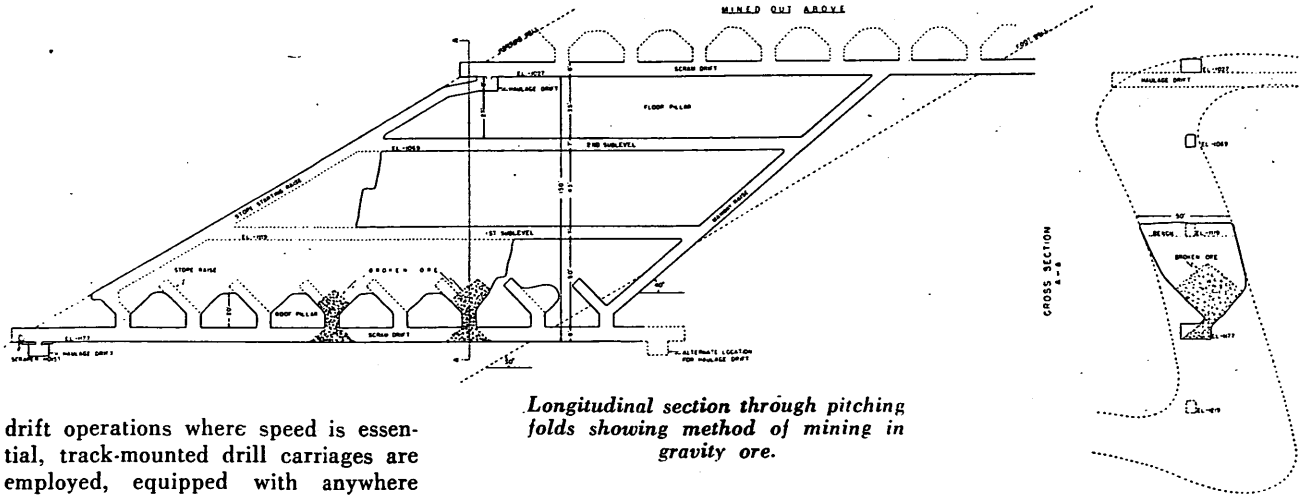
For drifting operations automatically fed 3-in., 3½-in., or 4-in. wet drills are used, depending on the nature of the ore or rock through which the drift is being driven. These machines are ordinarily mounted on 3½-in. column bars set up on each side of the heading. In drift operations where speed is essential, track-mounted drill carriages are employed, equipped with anywhere from two to five drills. These development headings are drilled using variations of the 3- or 5-hole standard burn cut and are blasted with 1¼ by 8-in. 60 per cent gelatin explosives. 96-lb. stoper drills are used in driving all raises and in our stoping operations both mounted and hand-held jackhammers are in use.

Drift rounds are mucked with air shovels whereas the ore from development raises and stoping operations is handled with scraper hoists.

Tramcars have a capacity of 10 long tons of broken ore. Ore trains, which vary in length from five to twelve cars, are hauled by 13-ton storage-battery locomotives.

Handling of Drill Bits

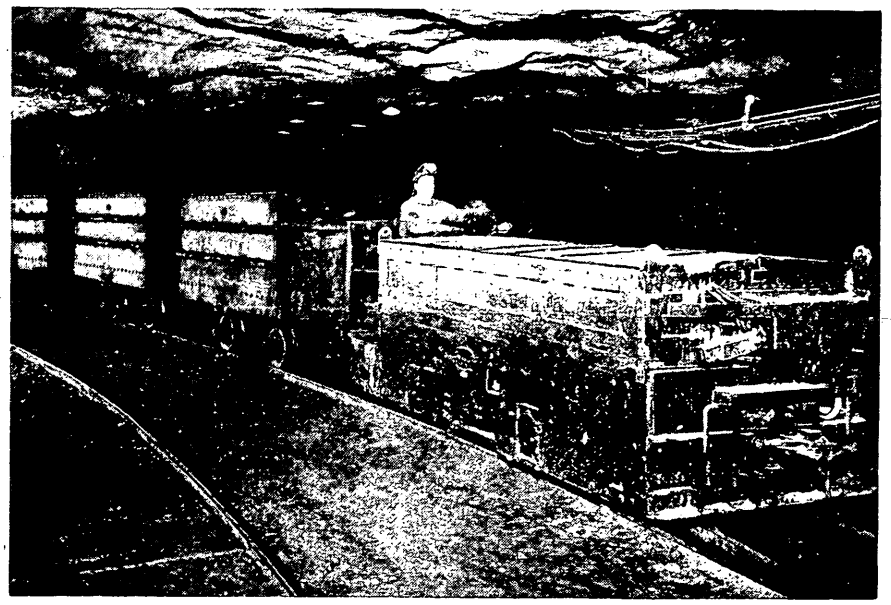
DETACHABLE bits are used in all drilling operations. All bits, drill steel, and hammer drills are reconditioned and repaired in a central shop located on the surface at the mouth of the slope. Because of the importance of this equipment in a mining operation, much study and experimental work have been carried on in connection with repair and maintenance. The location of the shop provides immediate access to the slope trackway and its



Longitudinal section through pitching folds showing method of mining in gravity ore.

equipment is arranged so that the material passes through it on a production-line system that minimizes lost motion.

Hollow round steel of 1¼-in. section is used with drifter drills, and hexagonal steel of 1-in. section with stope-hammers and jackhammers. Oil-fired furnaces are used in heating the steel in preparation for shanking on the drill sharpener. The opposite end of the drill steel is annealed so that it can be readily threaded. Threading is done on a standard 16-in. lathe equipped with cutting-off slide and a geometric expanding die head. After being threaded and shanked, the ends of the drill rod are tempered by heating them in a second oil-heated furnace and immersing in a bath of quenching oil. The quenching oil tank is water-jacketed for maintaining a constant temperature of the oil bath.



Storage-battery locomotive and train of ore cars.

Reclaimable, broken, worn, and used rods are put through the same process for reconditioning. When ready for service, rods are stored in bins and care is taken to rotate all steel so that no piece is used too often. This practice has materially reduced steel breakage from fatigue failure.

Each miner receives his supply of sharp bits when going on duty, and places the dull ones in a small hand truck stationed near the shaft landing when he comes off shift. The bits are then hauled into the shop, taken to a sorting table, and placed in bins according to size. Type 1 bits are used for jackhammers and stopers and Type 2 for drifters. The bits are reconditioned by hot-milling, heating of the bits in preparation for milling being done in pyrometer-controlled furnaces. The milling is handled by two men—a hot-mill operator and a helper. The latter removes the bits from the furnace and the operator, using a special handling tool, carries on the milling operation. The bits are then allowed to cool to atmospheric temperature before hardening.

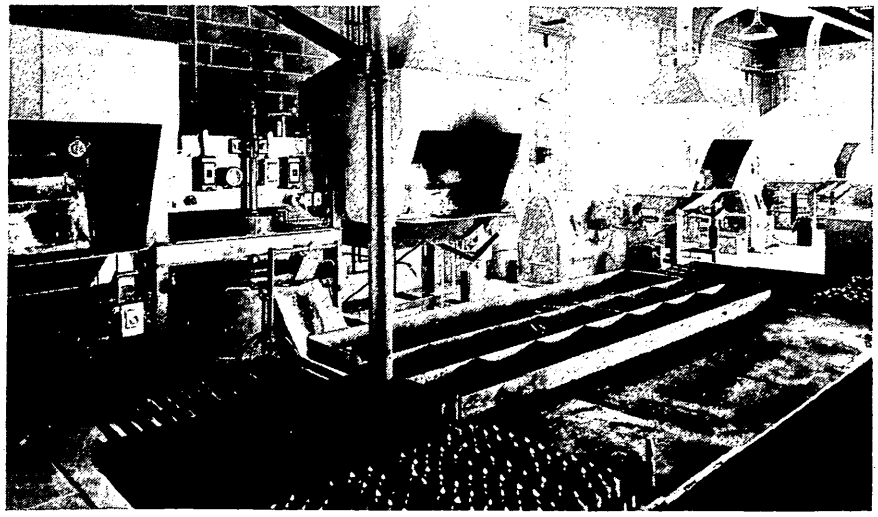
For the hardening process, the bits are placed in a second pyrometer-controlled oil furnace and heated to a prescribed temperature of 1440° F. They are removed one at a time and placed on an automatic quenching fixture. The automatic tempering machine was developed here at the Mineville property and is of the rotary type with eighteen individual quenching fountains. When a bit is placed on one of these, water rising around the cutting edge and through the center hole hardens it to the exact height desired. The speed is controlled so that the proper chilling effect is obtained in one revolution. After a bit has completed its travel, it is automatically picked off its station by an electromagnet: then dropped on a slide, from the lower end of which it falls into a hot-water bath below the floor level, the effect of the hot water being to normalize the steel. The intensity of the magnet is sufficient to cause the bit to hit it with considerable impact; this and the jarring effect when the bit drops on the slide removes any scale that may be adhering.

In this way, the entire hardening operation is automatically controlled and consequently no errors of human judgment can be made. As a result of this precise heat-treatment, the footage of drilling obtained per bit is substantially greater than with the old "human element" method, which failed to harden bits uniformly and produced many inferior ones. In addition, the automatic-control system has not only eliminated one man's labor, but has increased the rate of this operation from 100 to 1000 bits per hour.

Bits are reduced 1/16 in. in gauge at each resharpening and, after several reconditionings, difficulty was formerly experienced because not enough clearance was left between the wings to permit rock cuttings to pass freely. To overcome this, they are now regrooved on a form cutter, resulting in at least two more usages from each bit.

After the bits have been properly cooled, they are distributed to individual bins according to size, and are then strung on wires and moved by hand truck to a point near the shaft landing to be picked up by the drillers. Used bits are returned at the end of the shift on the same wires. They are then straightened on a pneumatically operated machine which was also developed at these operations.

A section of the drill shop is equipped for repairing and reconditioning all types of rock drills in use, and is so situated that the work done there does not interfere with other shop operations. All drills in need of repair are brought to this surface shop, which is convenient to the supply of spare parts, so that these can thus be ob-



Interior of drill shop.

Republic Steel's Operations at Port Henry, Mineville, and Fisher Hill

By Robert J. Linney
General Superintendent, Port Henry Division, Republic Steel Corp.; Member, A.I.M.E.

Robert J. (Bob) Linney

REPUBLIC Steel Corporation's iron-ore properties in the Adirondacks consist of mines, mills, and sintering plants in the Mineville and Port Henry area and at Lyon Mountain. This article will deal with the properties in the vicinity of Mineville and Port Henry.

In 1938, when Republic leased the Mineville- Port Henry operations from the Witherbee Sherman Corp., these properties had just come through some hard depression years. As a result, the mine development program was far behind schedule; most of the equipment needed replacement; and above all, the entire system of mining had to be completely changed to reduce operating costs. The concentrator had been in operation for many years; the process was dry and dusty. Machinery and equipment were either badly worn or entirely obsolete. The sintering plant, also long in operation, was badly in need of repairs.

The capacity of the Mineville operations at that time was equivalent to approximately 500,000 long tons of shipping product per year in the form of lump ore, concentrates, and sinter. The new goal set was approximately 1,000,000 long tons of shipping product per year. To accomplish this it was necessary to increase the hoisting capacity and step up the mine development program, provide additional equipment in the mines, build a new wet concentrator, and substantially replace a great deal of the sintering-plant equipment. This program was begun late in 1939 and continued on through 1940, 1941, and 1942. The operations are now in a position to produce 1,800,000 long tons of crude ore per year which in turn produces 1,000,000 long tons of shipping product.

Geology of the Deposits

MAGNETIC iron ore occurrences in this district fall in two main divisions—one igneous and the other sedimentary; the Republic Steel Corp. operates only in the sedimentary deposits. The igneous deposits, segregated from a molten mass, are in limited areas and are high in titanium. Originally, the sedimentary ore deposits were probably iron carbonate but pressure and heat have altered the carbonates to magnetic iron oxides (Fe_3O_4).

The ore deposits have been designated by different writers as beds, veins, pods, and lenses. In general, however, the bodies have a much greater extent along the strike and dip than at right angles thereto, and show a more or less lenticular form, in horizontal section, wider at the middle and tapering toward either end. These elongated lenticular bodies are more abundant in the northeastern part of the Adirondacks. The Mineville and Lyon Mountain ore bodies are good examples.

A great variation in chemical composition is shown by the ores. They range from lean varieties, consisting of magnetite intermixed with quartz, feldspar, and hornblende, to those made up of practically pure magnetite, the richest averaging from 60 to 70 per cent iron.

In this district, the richest ore body is the Old Bed at Mineville. The Harmony Bed contains less iron than the Old Bed, averaging from 35 to 40 per cent iron. The Fisher Hill and Lyon Mountain deposits yield from 25 to 30 per cent iron. According to the percentage of phosphorus present, the magnetites may be subdivided into low-phosphorus, Bessemer, and non-Bessemer grades. The bulk of the low-phosphorus ores has been produced at Lyon

Mountain, whereas Bessemer grades are obtained from Harmony and Fisher Hill. The Old Bed mine, which will run from 1 to 1¼ per cent in phosphorus, furnishes most of the non-Bessemer. Although the magnetites of the Adirondacks usually carry a variable proportion of sulphur, the beds being mined by Republic Steel at present yield practically none of this element.

In addition to the continual widening and pinching of these ore bodies, the intrusions of diabase dikes, usually resulting in displacement, have added considerably to the problem of following the ore. One with years of experience with these dikes can generally observe locally the direction in which the ore bodies are thrown, but if there is any doubt of this direction, the location of the vein is determined by diamond drilling.

In the Old Bed vein especially, considerable bending and folding has occurred. These irregularities have been definitely established and mapped at various elevations in the mine. This, of course, allows for a predetermined method of development which can be quickly altered to meet any changing localized conditions. Models of the ore bodies have been reproduced to scale and materially assist the mining department in laying out development plans well into the future.

Adirondack magnetites, with a few exceptions, cannot be used as direct shipping ores, but they readily lend themselves to magnetic concentration and sintering processes. The iron content of the shipping product will range anywhere from 68 to 69 per cent, with little moisture, compared with the 50 to 55 per cent iron, with 10 to 12 per cent moisture, of the Minnesota and Michigan hematites.

The tonnage of milling-grade ore available in the Adirondacks is unknown. When one takes into consideration that mining operations are now carried on in the Mineville properties at a depth of 7000 ft. along the dip, or 1350 ft. below the level of Lake Champlain, the ore reserves unquestionably are vast. Again, at Fisher Hill a diamond-drill hole cut the ore bed at a distance of approximately 8000 ft. along the dip from the surface outcroppings.

The late Frank L. Nason, in a paper read before the American Iron and Steel Institute in 1922, states that in the Mineville, Lyon Mountain, Ausable, Crown Point, Benson, and Sanford districts, the known ore amounted to 186,000,000 long tons. These estimates were obtained from the known outcroppings and surface drill holes. In addition to this, prospective tonnages based on structural lines were estimated to be 1,550,000,000, making a total of 1,736,000,000 long tons of iron ore then believed available in the Adirondack region.

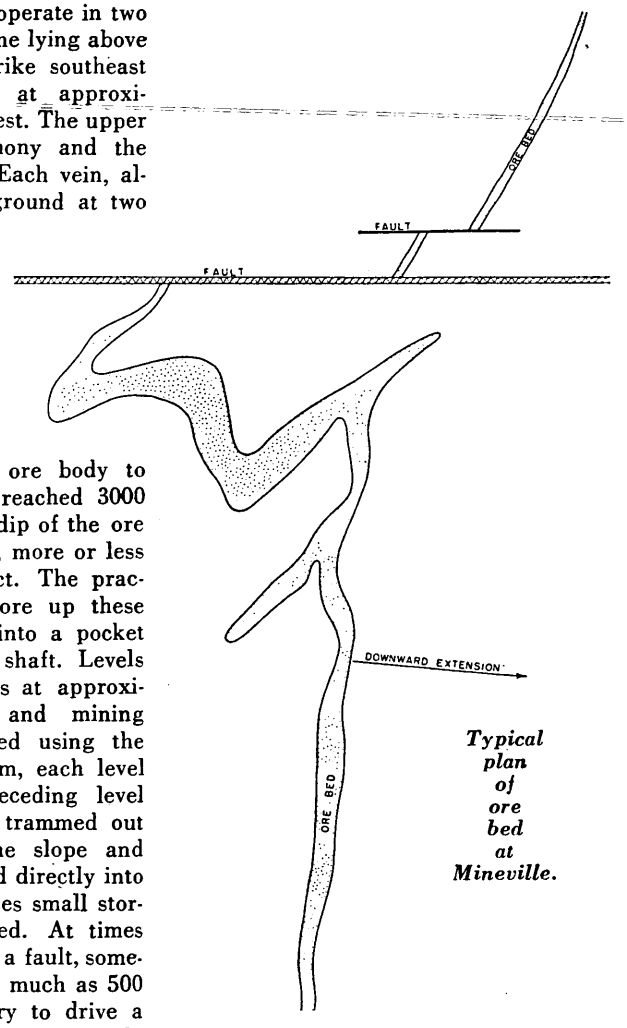
Mining Operations in Two Beds

THE Mineville mines operate in two distinct beds of ore one lying above the other. Both beds strike southeast and northwest, dipping at approximately 30° to the southwest. The upper vein is known as Harmony and the lower vein as Old Bed. Each vein, although connected underground at two different elevations, has been mined separately, including hoisting through separate shafts. The Harmony shaft is vertical, approximately 450 ft. deep, intersecting the vein at its bottom. From this point slopes have been sunk in the ore body to depths which sometimes reached 3000 ft. The slopes follow the dip of the ore body, resulting, of course, more or less in a "roller-coaster" effect. The practice has been to hoist ore up these slopes and discharge it into a pocket at the foot of the vertical shaft. Levels were driven off the slopes at approximately 75-ft. intervals and mining operations were conducted using the heading and bench system, each level breaking up into the preceding level for ventilation. Ore was trammed out along these levels to the slope and cars were often discharged directly into the skip. In other instances small storage pockets were provided. At times the slope would encounter a fault, sometimes throwing the ore as much as 500 ft. It was then customary to drive a drift through the rock to the ore body and then begin sinking another slope at this point. This meant, of course, that the ore hoisted on this slope must be transferred to the main slope where it was hoisted to the foot of the vertical shaft and from there to the surface. Through this system it was sometimes necessary to handle the ore as many as five times.

Practically all the mining operations were carried on with mounted jackhammers, usually drilling dry. Loading of the ore was done by electrically operated shovels and the tramming equipment consisted of small trolley locomotives and 1½-ton cars. In later years some of the rock drills were converted to the wet type and loading was accomplished with locally built scraper hoists.

Similar operating conditions were followed in the Old Bed vein.

After considerable study, it was decided to abandon completely the old and antiquated method of operation. It was decided to handle the ore from both veins through one central hoisting shaft and, inasmuch as this shaft was to be located on the Harmony or upper vein, means were also to be provided for the transfer of the Old Bed or lower-vein ore to the new shaft at the most convenient point underground. A new shaft, 8 by 20 ft., inclined at approximately 30°, was started at the surface and was projected through an old mined-out area and downward along the line of old No. 3 Slope. To connect the surface with the old stoping area underground, it was necessary to sink down through 350 ft. of overburden consisting of clay, quicksand, and gravel containing many large boulders, and raising through approximately 250 ft. of country rock, hard granitic gneiss. Sinking through the overburden was done by an outside contractor. The rock portion was driven by raising from underground and spreading the waste rock in old stopes by means of a scraper.

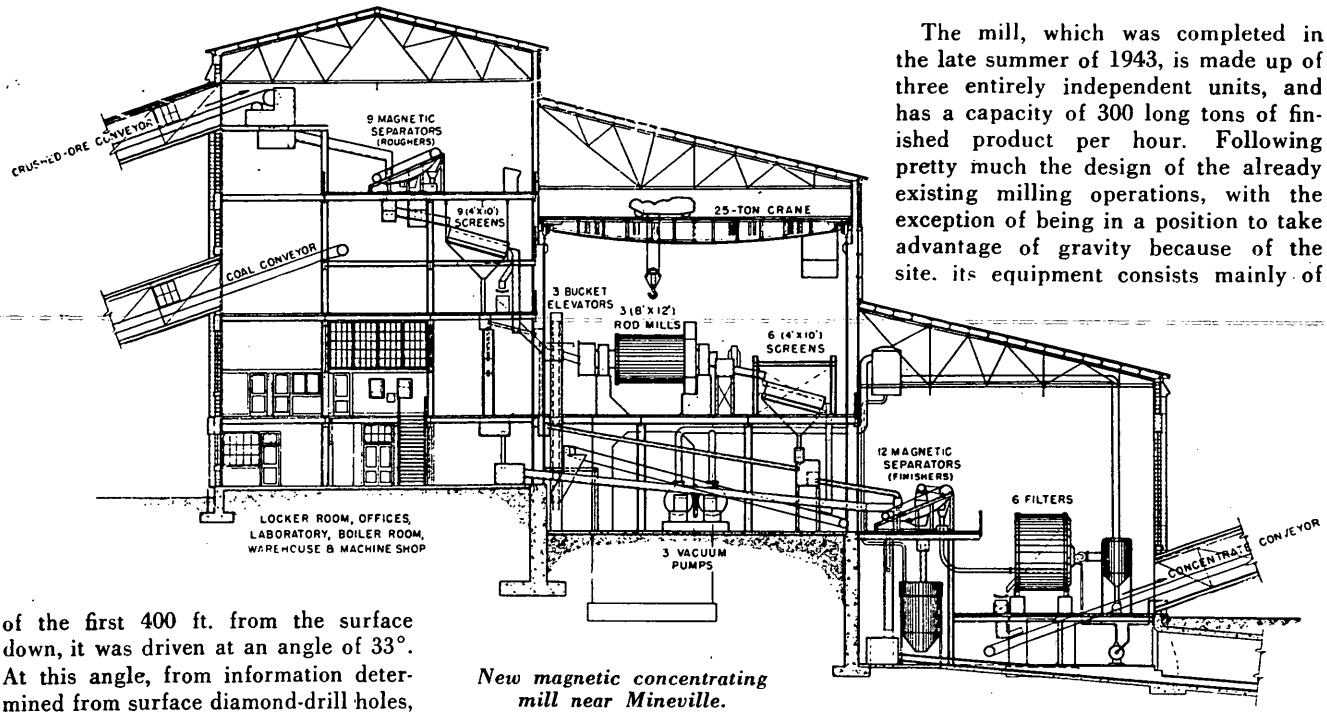


Typical plan of ore bed at Mineville.

Due to the character of the ground from the surface down to the bedrock, it was necessary to install structural steel shaft sets and reinforced concrete lining. The slope is equipped with double track and manway. During the

Arrangement of sintering plant.

Southern elevation of new concentrating and sintering plants near Mineville.



New magnetic concentrating mill near Mineville.

of the first 400 ft. from the surface down, it was driven at an angle of 33°. At this angle, from information determined from surface diamond-drill holes, it will remain in close contact with the ore body for a distance of at least 8000 ft. The upper part of the slope cut through an old excavation known as "Nigger pit," and to take advantage of this, the angle of the slope at this point is approximately 27°. Transition from the 27° angle to the 33° angle is accomplished by a large-radius vertical curve.

The slope is comprised of four compartments—two skipways in balance for handling the ore, a man and material skipway, and a concrete stairway and pipeway its entire length. Its construction is exactly the same as that of the main hoisting slope at the Mineville operations. When completed, the shaft will be 2000 ft. long, with five haulage levels and three pockets for handling the ore from tramcar to skip.

At Fisher Hill the slope and its hoisting equipment is designed to handle a little over 8000 long tons a day, which will be hoisted from loading pockets at three different elevations. The first-level ore will be handled from a point just below it. Ore from the second and third levels will be handled by means of ore-pass raises through a pocket above the fourth level; and the fourth and fifth level tonnage will be handled through a similar system—through a pocket just below the fifth level. All pockets are equipped with measuring chutes which will hold exactly one skip-load of ore.

The main ore hoist is a double drum, with both drums clutched, powered by two 1000-hp. d.c. motors. The hoisting rope is 1¾ in. in diameter and will handle 17 long tons of ore per skip.

All mining operations in the Fisher Hill ore body, because of its similarity in physical structure to the Mineville ore bodies, will be carried on under the same plan as that which is now in use in this district, and which has already been described, with slight modifications to meet local conditions. As the ore is delivered to the surface, it is also handled in pretty much the same manner as that of the Mineville ores, except that where larger tonnages are involved, equipment of larger capacity is used.

The change house, which connects directly to the entrance to the shaft, is modern in design. The warehouse and shops are also as close to the mine entrance as possible, to facilitate the transfer of repair parts and spares from these buildings into the mines.

Concentrator Close to Water Supply

IN picking the site for the new concentrating plant, the fact that it was to be a wet mill made water the most important problem. Experience in handling this extremely abrasive iron ore taught that handling ore by pumps was expensive and should be eliminated wherever possible. A site was thus chosen on the railroad line between Mineville and Port Henry where water could be obtained from the Bartlett Pond brook. As an auxiliary, a 16-in. steel pipe line was installed from a pumping station on Lake Champlain. By means of a hydro-separator, rake classifier, and a 200-ft. diameter thickener, three quarters of the water used could be reclaimed. The contour of the land is such that the crushed ore, from the time it enters the building until it leaves in the form of a finished product, flows from one unit to the next by gravity.

The mill, which was completed in the late summer of 1943, is made up of three entirely independent units, and has a capacity of 300 long tons of finished product per hour. Following pretty much the design of the already existing milling operations, with the exception of being in a position to take advantage of gravity because of the site, its equipment consists mainly of magnetic separators, vibrating screens, grinding mills, and filters. There is this exception, however, in that the magnetic separators used embodied improvements developed in this district. These machines, test units of which have been in operation on Harmony ore in the Port Henry mill for some two years, have greater capacity with a cleaner product, especially looking to the elimination of phosphorus, than any machine heretofore used here.

This new separator is made up of a heavy angle frame about 6 ft. wide and 10 ft. long, the top of which slopes at an angle of 30°. On either end and on top are mounted a head and tail pulley. An endless belt 54 in. wide and made up of 2-ply canvass with rubber covering is supported by the two pulleys. Between the head and tail pulleys and the upper and lower parts of the belt is mounted a magnet, 48 in. wide, consisting of twenty coils wired in four groups. For protection, these coils are enclosed in a stainless steel case filled with transformer oil. The magnet is connected in such a way that the current can be varied in any of the four groups. The underside of the belt travels in an upward direction toward the head pulley. Over the separator, and mounted to it directly ahead of the tail pulley, is a distributor which delivers the ore to a feedbox and pan mounted directly under the magnet. As the ore enters this feedbox it is washed up against the bottom belt, magnetic attraction holding the iron ore while the nonmagnetic material is carried away by gravity to a hopper directly underneath the tail pulley. As the ore is carried upward by the belt it passes over two spray pans, each with four

water sprays. These pans are placed within 1 in. of the belt and the spray thoroughly washes the ore as it moves along toward the discharge end. Inasmuch as the pans are within the magnetic field, any ore knocked off by the spray is immediately picked up again. The continual washing of the ore thoroughly eliminates all free gangue and other impurities. The concentrate is carried by the belt until it moves out of the magnetic field where it drops by gravity into a hopper.

Continuous Sintering Employed

At the lower end of the concentrating mill is the sintering plant. This operation differs from that at Port Henry in that it is of the continuous type. It consists of two 72-in., 14-windbox sintering machines each served by a 100,000-cu.ft.-per-min. suction fan, together with the necessary pug mills, conveyors, feeders, and ignition furnaces. Each machine has a capacity of 1500 long tons per 24 hours. Although the sintering operation differs mechanically, the process remains much the same—mixing fine anthracite culm with the concentrate, igniting, and sucking air down through the bed, which results in the fusing of the iron ore particles into a porous mass. The finished product, discharged directly into railroad cars, is dropped by gravity to a railroad scale for shipment to various blast furnaces.

Conveyors supplying crushed ore to new concentrator.

Such concentrate as is not sintered here will be shipped directly for sintering at several of the blast-furnace operations where the blast-furnace flue dust will be mixed with the concentrate.

Transportation Has Interesting Development

Operations at Mineville are connected with the Port Henry operations by the Lake Champlain & Moriah R.R. Although this railroad is a common carrier, it is used entirely in the transfer of crushed ore from the Mineville and Fisher Hill operations to the concentrating plant at Port Henry and to serve the new concentrating plant situated at what is known as the Switchback. The development of this railroad has been interesting.

In the early days of the mining industry in this area, one of the principal obstacles was the difficulty and expense of transportation of the product. Previous to the construction of railroads in Essex County, ore was hauled from the mine shafts by horse and wagon to the lake docks and shipped by boat. Due to the weight of both the crude and processed ores the quantities mined were limited to the haulage facilities of the day.

With the gradual development of the rich beds in this vicinity and the subsequent acquisition of control of the industry by the Port Henry Iron Ore Co. and Witherbee, Sherman & Co., a plank road was built between Mineville and Port Henry which greatly eased wagon transportation but was hardly the answer to problems of increased production nor conducive to low haulage cost.

In 1868 the Lake Champlain and Moriah R.R. Co. was organized, the charter first being granted to the Port Henry Iron Ore Co. with a half interest shortly afterward purchased by Witherbee, Sherman & Co. The road was constructed during the years 1868-9 at a cost of $200,000. An engine house at Mineville, with shops and roundhouse at Port Henry, was built in 1872-3.

Republic Steel's President Wysor, Vice-President White, and other officials on inspection trip to the Fisher Hill mine, September, 1943.

The original line of the road extends from the lake at Port Henry to Mineville and is about seven miles long. The steepest grade is about 222 ft. per mile and the rise from the lake is approximately 1300 ft. From Mineville, spur roadbeds were later constructed to the different producing shafts in the vicinity at New Bed mine, Fisher Hill mine, Cook shaft, and the O'Neil and Welch shafts. However, these spurs were later abandoned as the mining became centered at the Old Bed, Harmony, and "21" mines.

Little is known of the earliest equipment used on the road nor the size of rails originally laid except that the track was of standard gauge. The first locomotives were 35-ton steam engines that hauled 3-cu.yd., 5-ton capacity, 4-wheeled "jimmy" cars. At this time, and until larger equipment was purchased, switching at the Mineville and Port Henry yards was accomplished by horse team.

As larger equipment was installed and heavier cars were put into service, a lower Y or switchback was made at Port Henry but later abandoned and a big curve with underpasses built. 80-lb. yard and main-line tracks were then installed. In 1909 an upper Y or switchback was made by an extensive fill about 2½ miles up the bed from the lake to overcome the grade at this point and all rails were changed to 90-lb., laid on 6 by 8-in. ties and tie plates. Anticreepers were laid every 4 ft. along the track.

Until 1939 this arrangement was used to haul the concentrated ores from the mills at Mineville to the sintering plant and blast furnace at Port Henry. At the site of the sintering plant and blast furnace the road was extended from the natural cliff bench, about 70 ft. above the lake level, onto a trestle that was originally wooden and rebuilt several times. A steel trestle was finally built in 1929 and is still in use. Ore is dumped through the openings in this trestle onto a large storage space adjacent to the lake docks, or into bins that fed ore into the sintering plant. In 1916 a cantilever bridge crane was constructed over this dock storage yard. Until a few years ago, it was the largest of its kind in the world. This was used to load lake ore barges and to stock lump, concentrated, and sintered ore, and "anthrafine" coal. In recent years, the speed of rail transportation being more desirable, few ore barges have been loaded.

With the active mining operations hereabouts leased to Republic Steel in 1938 and the subsequent extensive re-

juvenation of the iron industry in this area following the lean years of 1929-38, the problem of the local transportation was thoroughly studied. The railroad's rolling stock consisted of two 65-ton steam switching engines, two 85-ton steam main-line engines, and approximately 100 30-cu.yd. two-hopper dump cars of 50 long tons each.

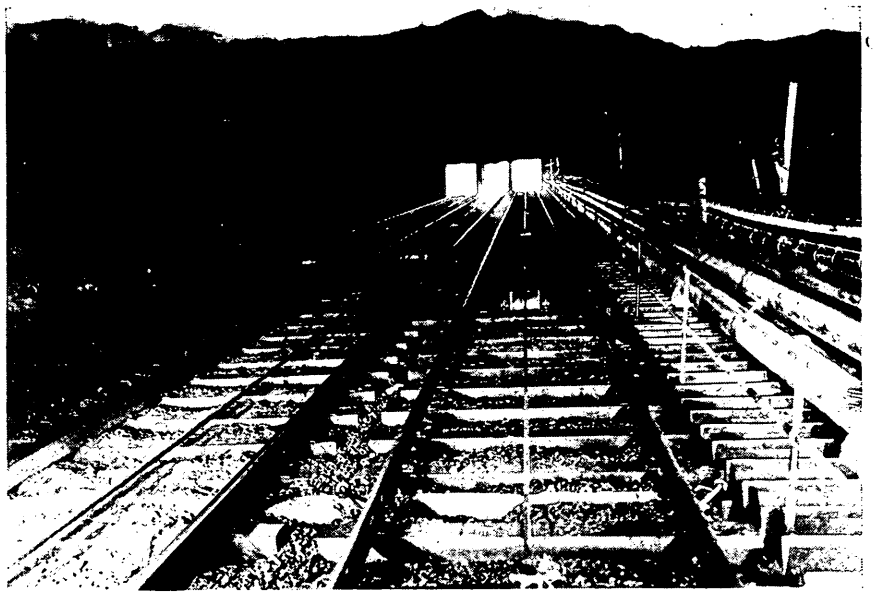
The main haulage problem up the now-used roadbed was the necessary haulage of empty cars up the grade. The 85-ton locomotives could haul only twelve to fourteen cars up the road, whereas twenty cars could be taken from the mines to the lake trestle. The cars were braked by air; each car was manually held on the steepest grades and the curves, where reduced speed was necessary. Trainmen rode the cars and performed this operation in all kinds of weather.

With increased production from the mines passing over the road, and since the relocation of the concentrating mill at Port Henry meant that crushed crude ore instead of concentrated ore had to be transported, a new 1000-hp. 125-ton Diesel-electric locomotive was purchased in 1940. In addition to this, fifty new cars of 35 cu.yd. and 60 long tons' capacity were purchased. During the ensuing year, the steam locomotives were retired from service and this one Diesel engine handled all of the main-line and yard switching work with approximately 1¼ million long tons of crushed iron ore hauled from the mines to Port Henry.

Since this grade was exceedingly steep and this was a new job for Diesel engines, some trouble was at first experienced from the pinions on the traction motors. The heavy load caused crystallization, cracking, and slipping of this pinion on the armature. After six to eight months of experimentation, an alloy pinion was developed that has withstood all the limit loads of the engine itself.

This new Diesel incorporated the advanced braking methods of the day. Each car was now equipped with both the automatic and Westinghouse straight-air braking system which entirely eliminated the hazardous work of trainmen riding the cars. In addition, the reduced fuel costs and engine maintenance now brought transportation into the economical bracket long sought for by mine operators. A second 1000-hp. 125-ton Diesel-electric locomotive was purchased, with 50 more ore cars of the same capacity, to handle the additional tonnage from Fisher Hill. This new engine was the same as the first but was equipped with all of the minor new features designed in the past year.

Another development took place in regard to the car wheels. The increased braking power required by the larger and heavier trains proved excessive to the chilled cast iron wheels used, so a complete change-over to solid steel wheels was made. Their use has eliminated chipping of the treads from the heat generated by braking, which had occurred with the chilled cast iron wheels. Another factor in this change-over was the increased protection to the trains on the main-line curves that are 14° to 17° radius.



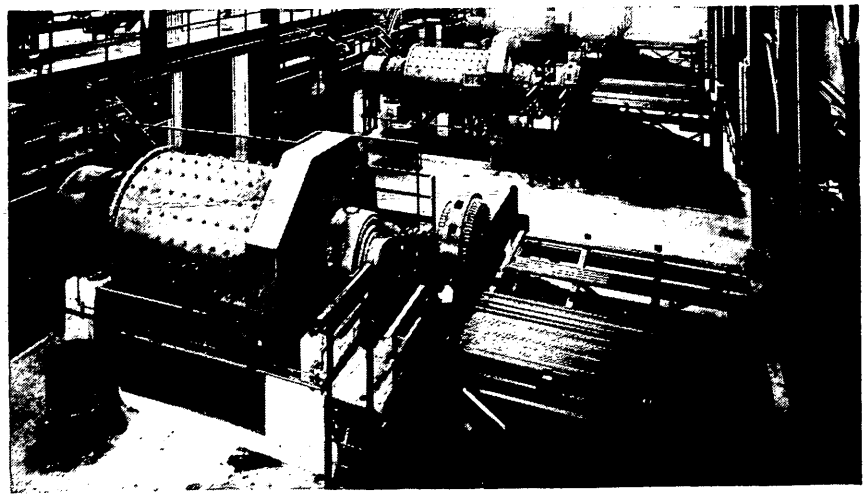
Looking up the shaft, Fisher Hill mine.

One item not as yet mentioned is the relative main-line train schedules. The improvement can only be shown in the tonnage comparisons of Diesel over steam haulage since the average time for the seven-mile upgrade run of 45 minutes and downgrade of 30 minutes has changed little. But the tonnage per train has almost doubled, and the present railroad equipment will be sufficient for the planned war production.

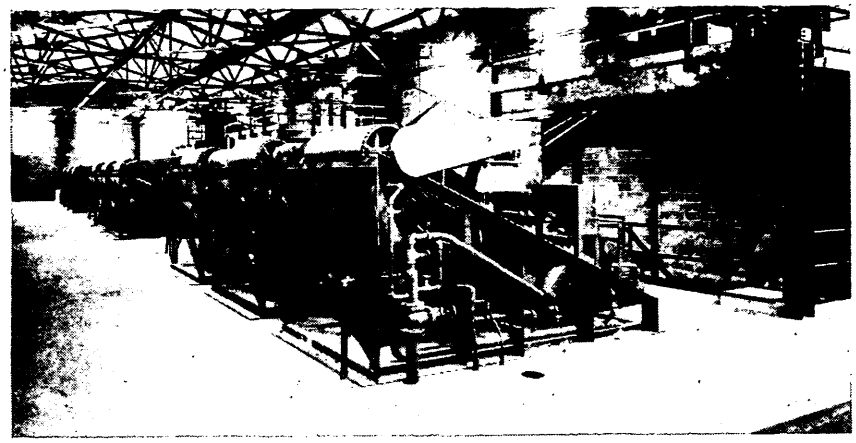
Housing, Health, and Safety

In addition to the 470 houses owned by the company and for which the average rent is $10 a month, the Federal Public Housing Authority has erected five dormitories with a capacity of sixty persons each, and 207 houses in units of various sizes to take care of 430 families.

The dormitories are situated about a mile from the change houses. Restaurant facilities are provided in a new restaurant about 300 yd. from the dormitories. The building and equipment are owned by the company but the restaurant is independently managed. The new houses, about 1½ miles from the mines, are similar in construction to the type erected all over the country to alleviate the housing situation in industrial areas. Rents vary



Rod mills in the new concentrating plant near Mineville.



Battery of wet magnetic concentrators in the new plant near Mineville.

between $14 and $20 per month depending upon the location and family size.

Water for the villages of Mineville and Witherbee is furnished by pumping the water from the mines, where it is chlorinated and stored in a 200,000-gal. reservoir. This source of supply is supplemented by water from a pond fed by brooks. This water is also treated before use and daily tests are made to ensure its purity. In addition, samples are taken at various times and submitted to the State Department of Health for analysis. The general health of the community is good and no serious epidemics have occurred for years.

There are three churches, a privately operated motion picture theatre, and the U.S.O. has established an industrial branch to direct the recreational activities of the employees living in the dormitories and new houses. The program will include the other residents but it is primarily for the people occupying the new housing units. No store is operated by the company, foodstuffs and merchandise being available in independently owned stores either in Mineville or Witherbee. Port Henry, six miles away, has sufficient stores to supply those who cannot fill their needs in the village stores.

Excellent hospital facilities are available in a hospital owned by the company. The staff consists of two physicians, one full time and the other part time, five nurses, and three orderlies. It has a sixteen-bed capacity but plans are to enlarge it to a 26-bed institution. It is well equipped with the latest X-ray and surgical equipment. Patients are admitted from within an area of 25 miles, and employment with the company is not a requirement for admittance. The employee rate, which includes members of employees' families, is $2.50 per day with a charge of $6.50 for the operating room. Four private rooms are available in the hospital for which no extra charge is made. Patients are moved to the wards when they are convalescing. Breakfasts are prepared in the hospital but the other meals are brought in from a near-by residence. During 1942 the hospital had four times as many outside cases as it did employee admissions. It also serves as a monthly clinic for visiting physicians from the New York State Hospital for Tuberculosis. Group insurance is provided for employees and many have their own hospitalization insurance.

A public school system, both elementary and high school, serves the villages of Mineville and Witherbee, and occupies two buildings. The buildings are complete and include science rooms and commercial and home economics departments, as well as a gymnasium. The staff is composed of 25 teachers and a supervising principal who directs the classes in both buildings. The average graduating class numbers thirty young men and women. Bus service is provided to bring the children to school who live outside of walking distance, particularly necessary during the extremely cold winter months.

PRODUCTION with safety, a policy adhered to throughout the entire company, is given special attention in the mines because of the natural hazards involved in mining. More hazards and dangers exist in the mines than in the crushing plant or concentrating mill, so the full-time safety supervisor devotes three quarters of his time to underground operations. Prevention of accidents is the goal of a well organized safety program and efforts are directed towards keeping a man from being injured rather than to see how soon a condition responsible for a lost-time accident can be corrected.

Education — Engineering — Enforcement, the well-known three "E's," are the basis of the safety program, following the company's procedure. This is basically the same whether in the steel mills or mines. Under the heading of education are safety meetings that include the supervisory force or department heads. They in turn hold departmental safety meetings with their staffs, and finally foremen or group leaders hold meetings with the men. The general foremen's and departmental meetings are held monthly, whereas the meetings with the men are held weekly. Rule books both for the surface and underground operations are given each new employee by his foreman when first reporting for work. Posters are attractively displayed on well-kept bulletin boards and extensive use is made of a sound strip film projector. Accidents occurring elsewhere in the company are circularized so that the hazard responsible may be removed if it is present in other operations. Unsafe practices and conditions are reported to the safety supervisor on a special form and he in turn uses these items as subjects of discussion in his talks with the foremen and employees.

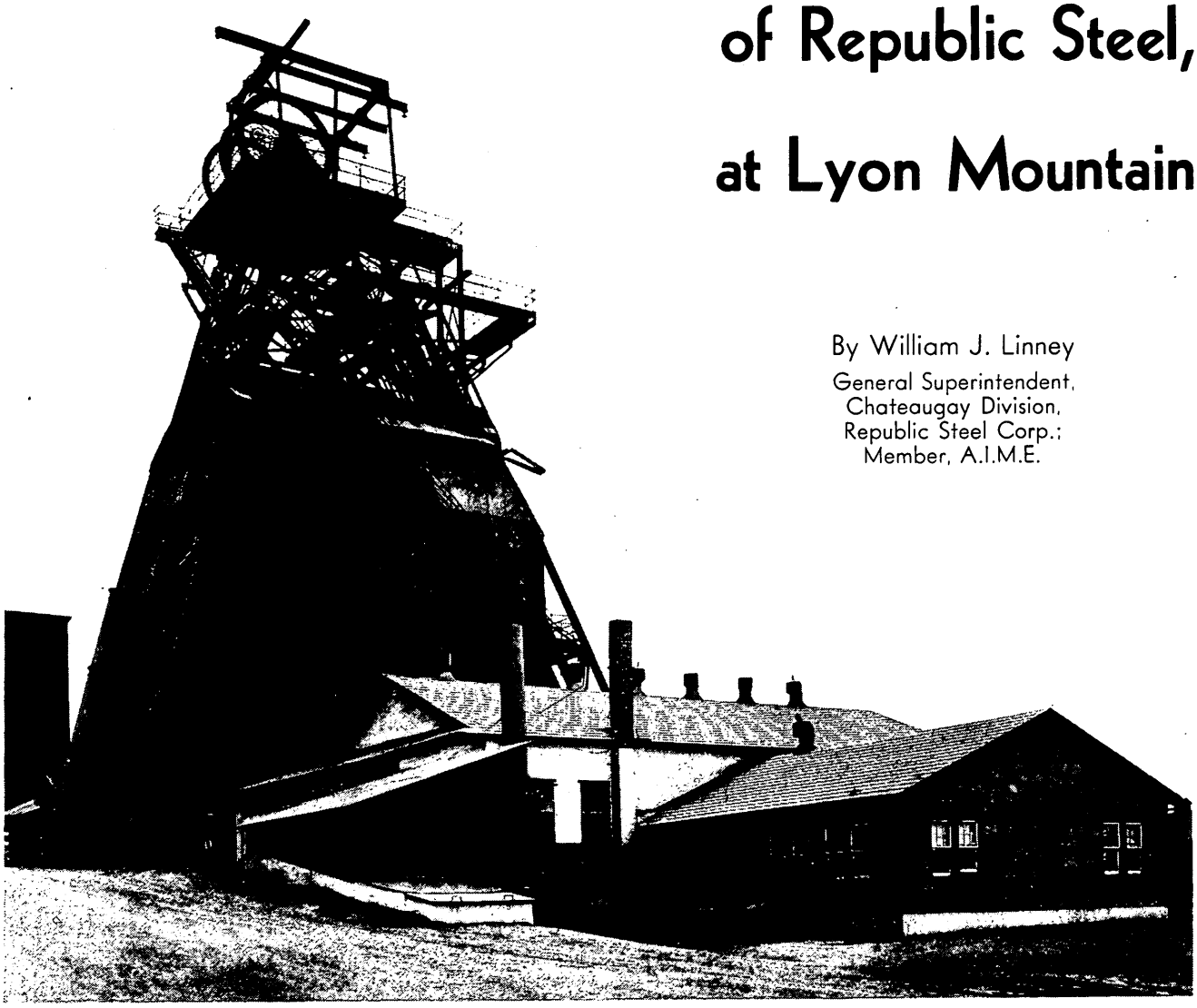
General safety orders of the company are supplemented by the code rules of the New York State Department of Labor, and the engineering program is directed to the prevention of accidents by proper guards, safety devices, and equipment. Wearing of hard-toe shoes is compulsory, except that during the four months of extreme cold weather, men working on the surface are not required to wear them. Enforcement of the rule that goggles must be worn wherever or whenever there is potential danger has resulted in saving many eyes. Use of safety belts and life lines in the mines is compulsory. Since every man working underground uses an electric cap lamp, the man who is actually engaged in mining or has occasion to work in a hazardous place is furnished with a safety belt equipped with a small strap to carry his battery lamp. All others are supplied with the ordinary lamp belt.

An extensive dust-control program is carried on under the direction of the Saranac Laboratory, whose field engineer makes semimonthly visits to the operations to check the results of dust counts and ventilation setup. Wet-drilling is compulsory under the New York State Code. Miners and others have periodical X-ray and clinical examinations, and all employees are given a complete physical examination when hired.

When the investigation of an accident discloses that discipline is necessary, the enforcement part of the safety program is administered by the District Manager. The success of the safety program can best be judged by the decrease in the number of lost-time accidents; for 1943 a reduction of 50 per cent has taken place with, of course, a corresponding decrease in severity.

Operations of the Chateaugay Division of Republic Steel, at Lyon Mountain

By William J. Linney
General Superintendent, Chateaugay Division, Republic Steel Corp.; Member, A.I.M.E.



Headframe on main hoisting shaft.

MAGNETITE ore from Lyon Mountain, so - called "Low Phos Chateaugay," has long been known to the iron and steel industry for its almost complete absence of impurities. These magnetites occur along the northern foothills of the Adirondacks in several parallel and folded stringers which are continuous for several miles, striking generally northeast-southwest and dipping usually over 45° to the northwest, or roughly toward the St. Lawrence River. Ore of minable thickness is found in shoots of various sizes as to length and breadth, but of undetermined and possible great depth.

The present hoisting shaft at Lyon Mountain is in the largest of the known shoots; one that is several thousand feet long at the surface and that has an average minable thickness of about 15 ft. of 25 per cent iron. Mineralized zones often penetrate further into the hanging or footwall, but these are not of economic grade. This ore shoot is folded and twisted into intricate patterns and is also cut by pegmatites, basic dikes, and faults.

W. J. (Bill) Linney

These veins or stringers of magnetites probably originated during the Adirondack mountain-forming period of the Pre-Cambrian, when the Grenville series of sediments was intruded by the syenites, anorthosites, granites, etc., to form the Adirondacks. Some of the Grenville rocks were not assimilated by the intruding magma but were probably trapped and metamorphosed in the mass of syenite. Dynamic forces of heat and pressure then went to work to form the "flow" structure, and chemical reactions took place in which replacement and transfer of minerals occurred, helped along by hot, gaseous solutions. Some of these reactions were apparently aided by the type of miner-

A main haulageway, Chateaugay mine.

als originally part of the old Grenville sediment. The result has been a concentration of magnetite and iron minerals in some of the gray gneisses. Thus the old Grenville rocks are responsible to a large extent for another of the many economic minerals already credited to them in other parts of North America.

Closely related to the magmatic intrusions and dynamic upheaval was the pegmatitic phase in which the more fluid acid rocks in turn invaded the Grenville ore series, thereby "cutting off" some of the ore. Intrusions of basic dikes and faulting were the latest of the forces which shifted the ore veins to some extent.

Exploration of these deposits is difficult because of the complicated folding, which often causes a drawing-out or thinning of the ore in anticlines, and a thickening in synclines or troughs. Further complications are encountered in dip-needle work as it is almost impossible to distinguish between a series of stringers and a minable ore shoot by use of this instrument. Consequently extensive use of the diamond core drill is found to be essential to both the exploration and development of the ore bodies.

Scrapers are used where the ore does not run by gravity.

Mining Practice

MAIN entrance to the mine is through an 8 by 24-ft., 63° incline shaft which is sunk, mostly in the footwall, to a depth of 2350 ft. The vein is tapped from the shaft at intervals varying from 150 to 300 ft.

Levels, or drifts, 8 by 12 ft., are driven east and west of the shaft on the strike of the vein. The drifts are driven on a rising grade of ¾ of 1 per cent in order to facilitate drainage and favor transportation, the loaded cars traveling on the downgrade. As the drifts advance, a permanent 36-in.-gauge track is laid with 60-lb. steel rail on good sound wooden ties spaced 30 in. apart, ballasted with iron ore or rock, whichever is met in driving the drift.

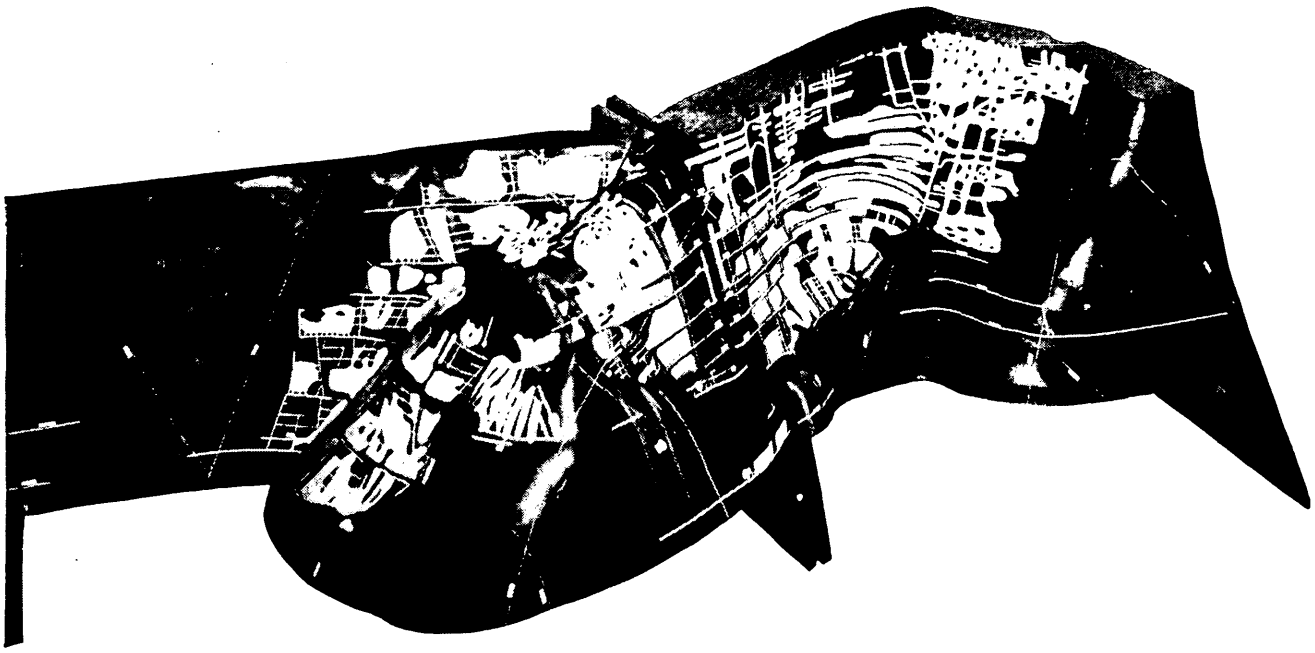
Wherever the vein is steep enough, which it is in most places, raises 5 by 8 ft., spaced on 30-ft. centers, are driven up into the ore above the drift, from which stopes are started for mining the ore for production. Chutes, usually made of 3-in. hardwood plank and timber with a ⅜-in. steel-plate liner, using an underhand arc gate and 10 by 30-in. air lift, are installed in the bottom of the raises through which the ore, after it has been broken, is loaded into the tram cars.

A variation of this method of installing chutes is to drive a subdrift approximately 40 ft. above the main drift. From this subdrift, raises are driven on 30-ft. centers. The ore comes down into the subdrift and is scraped by 50-hp. electric hoists to a main ore pocket. The advantage of this subdrift is that only one chute need be built. It is less hazardous when drawing ore from the stopes. At each end of a stope, a manway raise, 6 by 8 ft., is driven through to the level above for ventilation, pipe, and ladderways, and to afford entrance to the stope.

Three kinds of stoping methods are used in winning the ore: shrinkage, underhand, and scraper.

The shrinkage method is the usual one, consisting of drilling up into the ore, blasting it down, and drawing only enough ore out of the stope each day to leave space for the men to work, completing a daily cycle. This is continued until the stope is advanced to within 30 ft. of the level above, during which time about 40 per cent of the ore broken is drawn out daily, and 60 per cent left in. Thus, when the stope is completed, it is full of broken ore which can be drawn out at will.

The underhand method consists of drilling down into the ore and blasting it from sublevels which have been



Model of Chateaugay mine workings.

driven across the stope at 50-ft. intervals, connecting both manway raises. As the ore is broken, it falls by gravity to the loading chutes below, and can all be drawn out immediately.

In places where the vein is not steep enough for the ore to run by gravity the scraper method can be used. At convenient locations, a small, double-drum, electrically-driven hoist is installed, equipped with ⅝-in. steel cables, to which is attached a steel scraper. After the ore has been drilled and blasted it is scraped along the floor to small ore pockets, from which it is loaded by gravity into the tram cars.

Approximately half of the mine is using detachable bits and the other half conventional drill steel. As soon as possible detachable bits will be used exclusively. At present each level has a drill-sharpening shop but when detachable bits are exclusively used all sharpening and shanking of the steel will be done and all repairs to the drills will be made in one main shop on the surface.

Transportation of the ore from the working places to the main hoisting shaft is accomplished by storage-battery locomotives hauling steel, side-dump cars of the Granby type, each having a capacity of 6 long tons, and equipped with roller bearings. Loading and tramming of each train is done by two men, averaging 55 long tons per man per day for the entire mine.

After the ore is trammed to the main hoisting shaft, it is dumped into the ore pass which is connected to each level. At the bottom of this ore pass is a large 48 by 36-in. jaw crusher reducing lumps to 8 in. or smaller. The crushed ore is discharged by gravity into the skip loading bins, loaded into the 8-ton skips, hoisted at the rate of 1800 ft. per min., and dumped automatically into the bins above the secondary crushers in the headframe at the top of the shaft.

Splendid ventilation is provided in an unusual and inexpensive way. Openings from the old workings to the surface at the extreme westerly end of the mine are considerably higher than those on the easterly end. During the long, cold winter months, tremendous quantities of ice, hundreds of thousands of tons, accumulate in these workings, which cools the air sufficiently to cause large volumes to go down into the workings, forcing the smoke and gases out through the openings to the surface on the easterly end of the mine. The ice, of course, melts considerably during the summer months. but never entirely, enough fortunately remaining to ensure ample ventilation of the mine at all times.

The entire mine is arranged so that the water from all sections drains by gravity to points at, or near, the main hoisting shaft, from which it is pumped to the surface by electrically-driven pumps. The quantity is about 700 g.p.m. It is quite pure and contains no acids so is not destructive to the pumping equipment.

In many places in the mine. especially on the lower levels. much timbering must be done to support the back, or roof, of the main drifts, on account of the tendency of the ore and rock to spall and loosen.

The mine, as now developed and equipped, is capable of producing 4500 long tons of ore, by drilling eight hours per day, tramming ore sixteen hours per day, and hoisting twenty hours per day.

Milling and Concentrating

CHATEAUGAY ore, as mined, contains 25 per cent iron. By milling and magnetic concentration the iron content is brought up to 68 per cent. Pure magnetite contains 72.4 per cent iron and 27.6 per cent oxygen.

When the ore comes from the mine it is 8 in. and smaller in size. The fines, ½ in. and smaller, are screened out and conveyed by an 18-in. belt conveyor to the fine silo. The coarse, 4 in. and larger, is crushed to 3 in. by two 10 by 72-in. jaw crushers in the head house at the top of the main hoisting shaft. Ore from the crushers, along with the minus ½ in. which bypasses the crushers, is conveyed by a 30-in. belt conveyor to a crushing plant, where it is passed over a double-deck screen. That passing a ½-in. screen is conveyed to a fine silo; that passing a 2-in. screen and retained on a ½-in. screen is conveyed by a 30-in. belt conveyor to a coarse silo; and that passing over a 2-in. screen discharges into a 4-ft. cone crusher. The cone-crusher product is returned in closed circuit to the double-deck screen at the top of the crushing plant.

Material from the coarse silo goes to

Loading ore from stope into mine car.

two 36-in. pulley-type electromagnetic separators which are set and regulated to discard all material containing less than 3 per cent iron. The iron-bearing material retained by the separator is discharged to a 5½-ft. cone crusher set to ⅜ in. which product is conveyed by a 30-in. belt conveyor to the secondary crushing building.

Material from the fine silo is conveyed by an 18-in. belt conveyor to a belt-and-bucket-type elevator and discharged into a dryer. This is a steel stack, 125 ft. high, lined with firebrick and equipped with cast-iron baffles, heated by the hot gases from a chain stoker, burning anthracite rice coal. Thoroughly dried, the material goes on to a 24-in. steel conveyor and is discharged into the same 30-in. belt conveyor that carried the product from the 5½-ft. cone crusher.

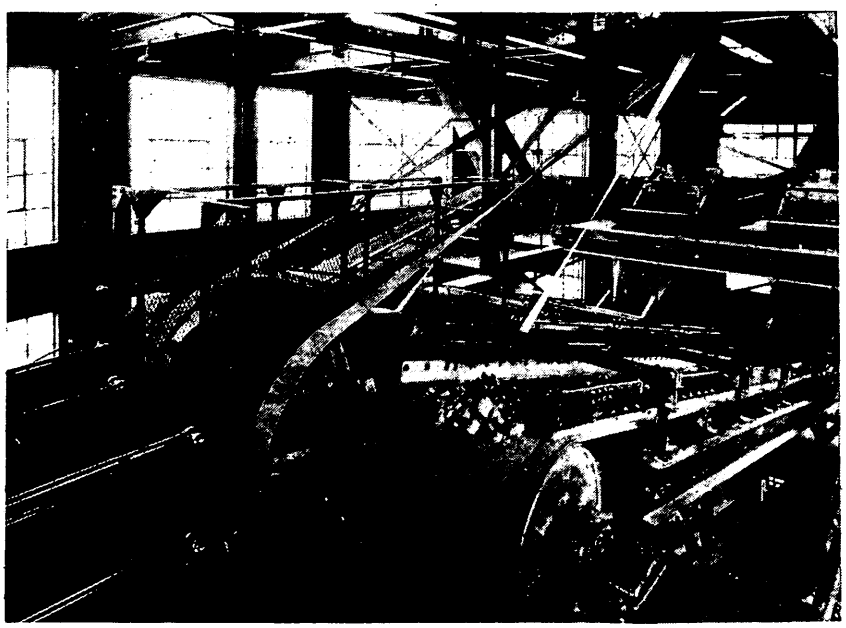
The next step is to pass it over two 5 by 12-ft. double-deck vibrating screens, having ½-in. openings on the top deck and 10-mesh openings on the bottom deck. The portion that passes over the ½-in. screen is returned in closed circuit to the 5½-ft. cone crusher and the 10-mesh oversize goes to four 4 by 12-ft. vibrating screens with 10-mesh openings. Oversize from the vibrating screens goes to four 36-in. pulley-type magnetic separators which are set and regulated to discard all material containing less than 3 per cent magnetic iron. Magnetic material retained by the separators is conveyed by 30-in. belt conveyors to a 9 by 16-ft. dry rod mill, the product from which is returned in closed circuit to the screens at the top of the building.

Ore passing the 10-mesh screens is sent to a 30-ft. centrifugal air separator for taking out the minus-100-mesh material, which is sent direct to wet magnetic separators. The coarse material from the air separator, which is minus 10 mesh and plus 100 mesh, is conveyed by a 30-in. belt conveyor direct to the bins over the dry magnetic separators in the concentrating house.

Minus-10-mesh dry material now passes over sixteen 30-in. drum-type, electromagnetic separators, making a concentrate containing 68 per cent iron or better, and a tailing containing not more than 3 per cent magnetic iron. The middling from these separators falls by gravity to sixteen separators of similar type directly below, which also make a concentrate containing 68 per cent iron or better, and a tailing containing not more than 3 per cent magnetic iron. Middling from these separators is returned to the bins at the top of the building in closed circuit. Concentrate is sent to two 500-ton storage bins at the top of the sintering plant and the tailing goes to the tailing pile.

Because the minus-100-mesh material cannot be efficiently separated on dry drum-type magnetic separators, it is sent to wet inclined-belt magnetic separators which make a 70 per cent iron concentrate and a tailing containing not more than 2 per cent magnetic iron. The concentrate is sent to a filter and then to the storage bin above the sintering plant.

Ore tailing, or rock that has been separated from the ore, has become a valuable by-product. Each commercial size is stored separately in piles above a concrete tunnel, through which a 36-in. belt conveyor takes it to railroad cars for shipment to market. Hundreds

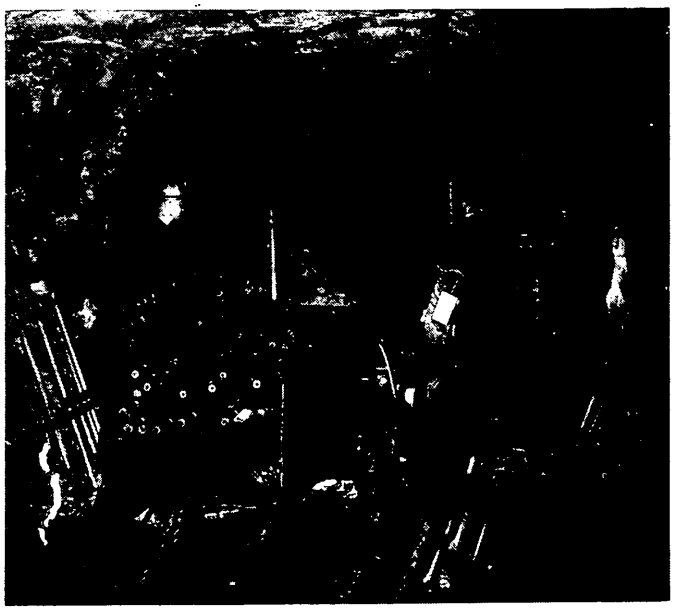


Coarse magnetic separators, Chateaugay Division.

Bill Linney and his mine staff.

of thousands of tons of ore tailing was shipped in 1942.

The concentrating plant has a capacity for treating efficiently 4500 long tons of crude ore in 24 hours, from which 1400 long tons of concentrate containing 68 per cent iron is produced. Within the next few months the concentrating mill will be changed over entirely to the wet process, using wet inclined-belt magnetic separators.



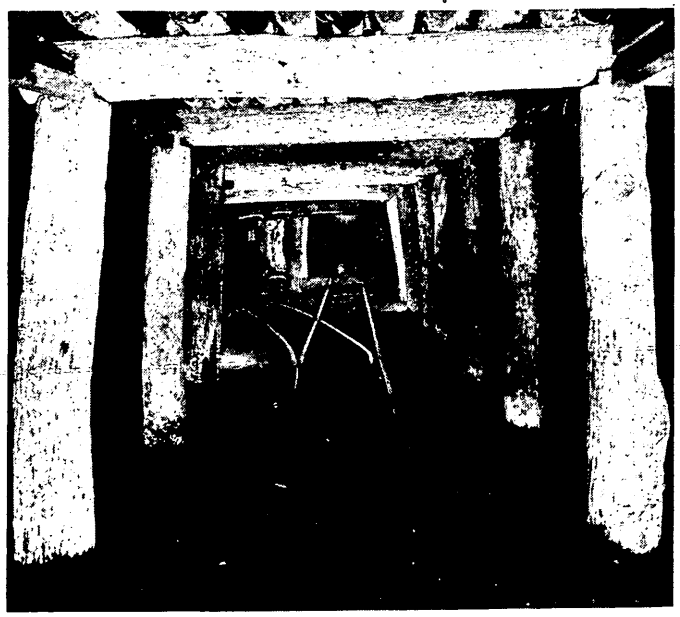
Drilling drift round with "jumbo", Chateaugay mine.

Sintering the Concentrate

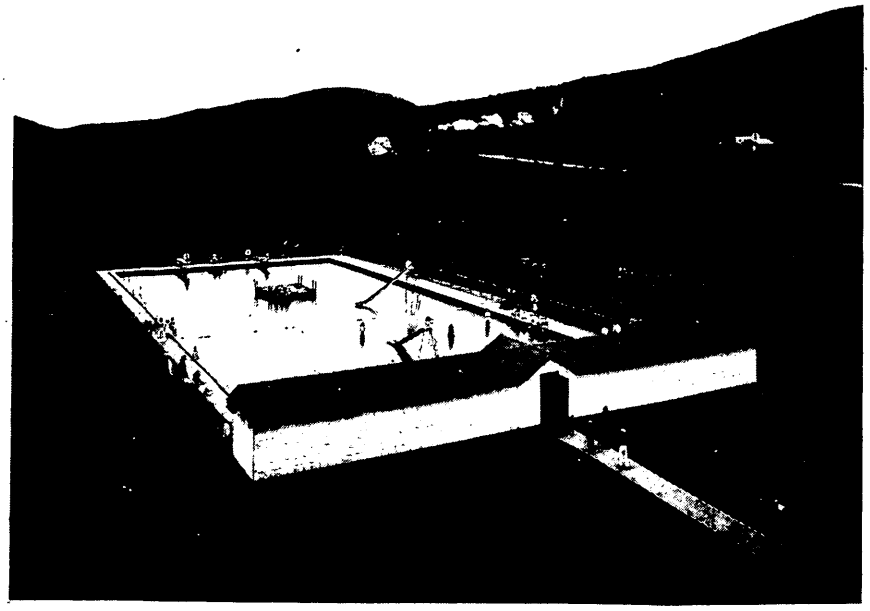
SINTERING is accomplished by means of the continuous process. The sinter machine is 6 ft. wide and 82 ft. long, comprised of a series of grates known as pallets which are mounted on wheels for traveling on a continuous track.

Concentrated ore is first mixed with about 5½ per cent by weight of anthracite. The grade of fuel used is about the size of granulated sugar, high in carbon and low in ash, and is known as "anthrafine." As the fuel and concentrate are being mixed, by means of a pug mill, a small amount of water is added as a temporary binder. The mixture of ore and fuel is spread evenly on the pallets of the sintering machine to a thickness of about 7½ in., and the fuel is immediately ignited as it passes under an oil-heated ignition furnace, comprised of refractory brick, and a retort, or combustion chamber, suspended by a steel and cast-iron frame.

Combustion is assisted by a downward current of air, drawn through the mixture or bed, the entire length of the machine, by a large induced-draft fan with a capacity of 90.000 cu.ft. of



A timbered haulageway.



air per minute. The speed at which the machine travels is regulated so that, by the time the material reaches the discharge end, the fuel is entirely burned out and the process completed. The sinter is then discharged over a set of stationary grizzly bars, spaced 1 in. apart, which take out the fines, allowing only the coarse material to go to the railroad car for shipment. The fines are returned, by means of an inclined belt conveyor, and are mixed with the incoming feed to the sintering machine.

The plant has an output capacity of 58 long tons of sintered ore per hour, six days per week, and can be operated continuously and efficiently 24 hours daily by suspending operations 8 hours each week.

Public Welfare

THE Company owns 300 dwellings and two boarding houses in the village of Lyon Mountain and vicinity, many of which are equipped with steam heat, bath, hot and cold water. The average rent per dwelling per month is about $10. Water for the village is furnished from a 1,000,000-gal. reservoir in the mountains high above the village.

Two churches and a fine school with large gymnasium are provided; also an outdoor swimming pool 75 ft. by 150 ft. which is used as a skating rink during the winter. In addition, there is a fine baseball park equipped with bandstand, bleachers, and dugouts. In 1935, the Lyon Mountain baseball team won the Northern New York State League pennant, competing against teams from Plattsburg, Saranac Lake, Malone, and other large places.

There are two up-to-date I.G.A. self-service general merchandising stores, operated independently by an outside concern. Prices charged in this store are almost identical with those charged by the large chains in the cities. These people also operate an up-to-date restaurant and tavern in the village. The only alcoholic beverage sold in the village is beer.

Two full-time doctors are employed by the Company; they also conduct a private practice for the people in the village and vicinity. A splendid program of safety is carried on at all times with a full-time safety supervisor.

Top—Lyon Mountain village with concentrator and sintering plant and shaft headframe in background.
Center—Public school.
Bottom—Swimming pool.

MacIntyre Development of National Lead Co. at Tahawus, N. Y.

By the Staff

Otto Herres,* Manager
F. R. Milliken,* Assistant to Manager
C. R. Begor, Mine Superintendent
P. W. Allen,* Assistant Mine Superintendent
L. S. Taylor,* Mill Superintendent
C. A. Remington, Metallurgist
F. E. Gleason, General Master Mechanic
R. C. Stephenson,* Geologist
*Members A.I.M.E.

ON the headwaters of the Hudson River, in a sparsely populated area of the north woods at Tahawus, N. Y., thirty miles from the nearest railroad, is the MacIntyre property of National Lead Co. Operations involve the mining and processing of titaniferous iron ore to produce ilmenite concentrate, and magnetite concentrate containing vanadium, for use in the production of iron, titanium, and vanadium in the war program. Accordingly, MacIntyre at present is classed as a war plant. More than 3000 long tons of ore is mined daily by opencut methods and treated in an ore concentrating plant.

The ore is drilled with blasthole drills, wagon drills, and jackhammers, and blasted with dynamite ranging from 60 to 90 per cent strength. Broken ore is loaded with large electric power shovels into Diesel mine trucks carrying from 15 to 30 long tons to a load and transported to a crushing plant where it is crushed by jaw and cone crushers. Crushed ore is screened and then ground in rod mills and passed through magnetic separators to recover the iron in the form of magnetite concentrate. Reject from the separators carries titanium minerals and is treated on gravity concentration tables to remove rock and waste material. Table concentrate is dried and passed through magnetic separators of another type to clean the ilmenite concentrate, the product then being transported by truck to the nearest railroad point thirty miles away at North Creek, N. Y., for shipment by rail.

Magnetite concentrate, which carries the vanadium, is transported in a similar manner to North Creek and shipped to steel plants, or stock-piled for processing in a sintering plant now under construction. A small tonnage of magnetite concentrate is taken for the manufacture of ballast blocks for the U. S. Navy. It is useful for this purpose because of its high specific gravity. All ilmenite concentrate is shipped to plants of the National Lead Co., Titanium Division, and one other consumer, for further processing into titanium products either for war purposes or essential civilian use.

At this time, MacIntyre is producing 600 long tons of ilmenite concentrate daily and approximately 1200 long tons of magnetite concentrate. The plant works 24 hours a day seven days a week with the exception of every second Sunday when operations are suspended in accordance with New York State labor regulations which require one day of rest in fourteen under war emergency conditions. At that time repair and maintenance work is done. Opencut mine operations are carried on two shifts daily throughout the year with the same exception. The crushing plant is being enlarged to permit increased production. In addition to this enlargement, the Defense Plant Corp. has under construction a Greenawalt sintering plant at Tahawus, to put the magnetite concentrate in more suitable form for use in an iron blast furnace. The Defense Plant Corp. also has under way the construction of a railroad connection from MacIntyre to the Delaware & Hudson Railroad at North Creek, N. Y., to provide a more suitable and certain means of transportation of products essential to the war program than the transportation by truck which now is used.

Construction of the MacIntyre plant was commenced during the summer of 1941, when the supply of titanium ores, formerly brought mainly from India, was cut off by the war. The development was fully financed by the National Lead Co. Construction was completed during the late summer and fall of 1942, but at that time there already was a serious shortage of labor, so the property was handicapped greatly in getting together an operating organization. On account of man-power shortage and the isolated situation of the mine, workers from the neighboring Adirondack villages and woods entirely inexperienced in mining and ore milling were the only source of labor available. All available workers from more distant communities had been taken by the large industrial plants of the Schenectady and Massena areas.

Approximately half of the workers at MacIntyre live in neighboring villages and drive an average of 25 to 30 miles to work, involving 50 to 60 miles travel daily. No public transportation is available and the small villages are too scattered to make such means of transportation feasible under war travel restrictions.

Excellent housing facilities are provided at Tahawus, but they are inadequate for the present needs of the operation. An additional 24 housing units now are being built supplementing the 43 dwellings the company built during the years 1941-1942. All houses are constructed of native lumber stained to present an attractive appearance against the surrounding woods, and are insulated. Each house has modern facilities including running water and electric lights, and many have built-in garages. A fifteen-family apartment house is furnished with electric ranges and heated from a central plant. A modern dormitory accommodates forty men in individual rooms and a restaurant in conjunction is furnishing meals to 100 men. A compact general store has available everything from frosted foods and fresh vegetables and fruits to clothing and hardware.

Water for all uses at the mine is provided from Sanford Lake, which is a natural widening of the Hudson River. Water is pumped through a 24-in. line to a reservoir of 750,000 gallons capacity, approximately 4000 ft. from the intake at the lake and 225 ft. above the level of the lake. Process water is drawn from the inlet line for the mill at a point between the lake and the reservoir. A water-treatment plant is in operation at the reservoir, drawing water for treatment for domes-

Otto Herres

tic and drinking purposes and also for use as boiler feed water. Water for domestic purposes is treated with chlorine, aerated, and filtered. For the treatment of sewage there are two plants, serving the village and industrial buildings.

Severe weather conditions are experienced, and winter temperatures drop as low as 40° below zero. Drills, trucks, bulldozers, and power shovels used in opencut mining are housed or provided with cabs to protect workers from subzero weather and are heated electrically or otherwise. The mine has worked every day thus far in 1943, including holidays, except for the required one day of rest in fourteen.

Mine, mill, and shop operations are highly mechanized, as are also plant and village facilities. Under the circumstances, it has been possible to maintain a comparatively large production by careful management and close supervision in spite of a critical shortage of man power during the war emergency. The replacement schedule filed with Selective Service headquarters shows more than sixty occupational classifications for a total of 233 employees.

At the mine, production now is running at the rate of approximately 55 long tons per operating man-shift, and in the mill, approximately 57½ tons of ore per operating man-shift, in both instances with relatively inexperienced labor.

Daily shipments of concentrates are moved by trucks over winding Adirondack mountain roads through the woods to North Creek. Winter snows and subzero temperatures present a problem, but quantities of up to 2000 long tons have been handled daily a distance of thirty miles. Trucks are limited to approximately 13-ton loads by New York State highway restrictions. Cost of transportation by trucks averages throughout the year approximately three cents per ton-mile.

Geology of the Deposit and Immediate Area

THE Sanford Hill ore body now being mined is one of four known to exist in the Lake Sanford area, the others being the Ore Mountain, Calamity-Mill Pond, and Cheney Pond bodies, the location of which may be found on the sketch map. They all lie within the core of the Adirondack anorthosite massif.

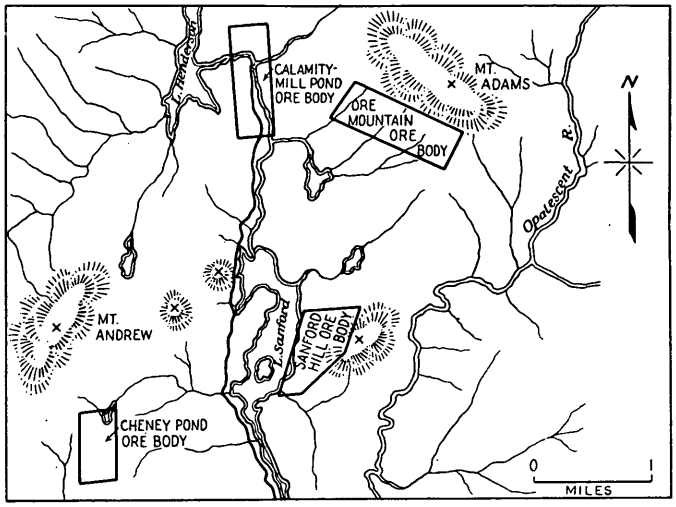
In the Lake Sanford area the anorthosite series consists of anorthosite, gabbroic anorthosite, gabbro, and titaniferous magnetite. These rocks represent a genetically gradational series and differ from one another primarily in the ratios of the constituent minerals. The anorthosite is a bluish-gray to almost white granular rock with a coarse to medium grained texture. The feldspar is labradorite, typically occurring as large tabular crystals. The anorthosite may grade into gabbroic anorthosite by a decrease in the percentage of plagioclase phenocrysts and an increase in the mafic minerals: hornblendes, pyroxene, garnet, and biotite. The gabbro is a gray, medium to fine, equigranular rock which may contain a few plagioclase phenocrysts. It contains 35 to 75 per cent mafic minerals and less than 15 per cent plagioclase phenocrysts.

The gabbro may grade into anorthosite through gabbroic anorthosite or it may intrude anorthosite. Gabbro may grade into ore by an increase in ilmenite and magnetite. The minerals of the anorthosite and gabbro are essentially the same.

Flow structure in the anorthosite does not appear consistent in the area, nor does it apparently bear any relationship to the concentration of the ore. In the gabbro, the foliation is strong and lenses of ore occur comformable to the foliation; contacts of the bands of ore with gabbro are gradational. The contact between anorthosite and ore is always sharp and is marked by a strong reaction zone, which consists of a zone of myrmekitic garnet nearest the anorthosite, and zones of hornblende, pyroxene, biotite, and spinel nearer the ore. An accompanying photomicrograph shows these relations.

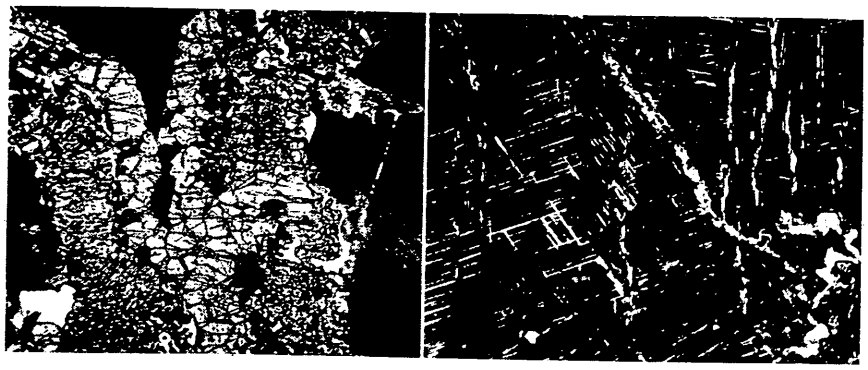
Ore in the Sanford Hill and Ore Mountain deposits, the largest of the four, concentrates in or near the contact between ore-bearing gabbro facies and anorthosite. The ore occurs as irregular lenses in gabbro and as replacements in the anorthosite, the largest concentrations of rich ore occurring in contact with anorthosite. The gabbroic facies of ore are most common in the Calamity-Mill Pond body, though some small scattered occurrences of ore are associated with anorthosite. The Cheney Pond ore body outcrops as a well defined conformable lens of lean ore in gabbro; it is small and not of commercial significance.

Numerous slickensided joint surfaces indicate considerable post-ore adjustment within the area, though it is not likely that the displacement along these surfaces was more than one foot.



Sketch map showing location of ore bodies of the Sanford Lake area, New York.

Ore occurring in gabbro is hypidiomorphic and the grain size varies from 1 to 2 mm. Gangue minerals have the same approximate size as the ore minerals and occur disseminated through the ore. Concentration of the ore into bands which grade into the gabbro suggests that the ore was formed *in situ*. Though the ore was formed in place, some movement of ore occurred along bands in the already consolidated gabbro. Ore in anorthosite is coarser than the ore in the gabbro, the grain size being 2 to 3 mm. Much of the ilmenite and magnetite occur in nearly euhedral crystals. Microscopic intergrowths of ilmenite in magnetite are



Photomicrographs of (left) the garnet-rich reaction zone between feldspar of anorthosite and titaniferous magnetite ore (X 47) and (right) the abundant intergrowths of ilmenite (light) in magnetite (dark). (Etched with HCl) (X 61).

more common in the ore associated with anorthosite. The ratio of ilmenite to magnetite is higher in the fine-grained gabbroic types of ore than in coarse-grained ore occurring in anorthosite.

Like all titaniferous magnetite ores, the ore of the Sanford area is vanadiferous, the crude ore containing slightly less than 0.5 per cent V_2O_5. This vanadium is probably held in solid solution in the magnetite.

The titaniferous magnetite deposits of the Lake Sanford area were formed during the intrusion of the Adirondack anorthosite series, and it is believed that the magma from which the rocks of this area crystallized was of gabbroic-anorthosite composition and locally carried excessive amounts of titanium and iron. The phenocrysts of plagioclase compacted through flowage and the ore-bearing gabbro residuum were filter-pressed out of the anorthosite series, a postulate which is substantiated by gradational relations between gabbro and anorthosite. Further concentration through differential crystallization gave rise to an ore residuum of titanium and iron. Part of the ore crystallized as concordant conformable bands in gabbro to form the facies gradational between gabbro and ore. Also, the ore residuum replaced anorthosite to form large masses of coarse-grained ore, the replaced anorthosite being, in part, completely solidified and, in part, only partly solidified at the time of introduction of the ore. In some places the ore engulfed blocks of anorthosite and penetrated it along joint planes. Elsewhere, the uncrystallized groundmass of the anorthosite was replaced, leaving nothing but isolated phenocrysts. Gradational relations between gabbro and both ore and anorthosite are conclusive proof of the consanguinity of the titaniferous magnetite and the enclosing gabbro and anorthosite.

Mining Operations on Sanford Hill

THE ore body of titaniferous magnetite being mined outcrops on the western slope of Sanford Hill; at the surface, it is approximately 1900 ft. long by 900 ft. wide. The depth of overburden above the ore varies from practically nothing at the uphill edge of the ore body (elevation 2100 ft.) to as much as 25 ft. at the downhill edge (elevation 1770 ft.). Before stripping operations were commenced, there was a cover of second-growth trees, principally birch, maple, aspen, and spruce.

Opencut mining operations, with benches at 35-ft. vertical intervals, were begun in the late fall of 1941 at the lower edge of the ore body, benches being excavated in the hardpan overburden by small Diesel-powered shovels. At the present time, the higher benches on the hill are being cut in the following manner. Two tripod-mounted drifters are used to drill a series of 16-ft. lifter holes from one end of the ore body to the other at the proper bench elevation. When these have been blasted, a footing is obtained for a Diesel-powered shovel equipped with a 1½-cu.yd. dipper. After the initial cut has been made, the face thus exposed is drilled with wagon drills to a depth of 22 ft. Successive cuts are made with the wagon drills to produce a face high enough for well drilling. At present, five of these wagon drills are operating in the mine, each averaging about 150 ft. of hole per shift. Air is supplied at 90 to 100 lb. per sq. in. by a 1000-cu.ft. per min. compressor installed at the machine shop and by a 650-cu.ft. per min. semi-portable compressor at the north end of the mine. A portable 315-cu.ft. per min. compressor, Diesel-powered, is also used.

After development with the wagon drills has been completed, all further drilling is done by four well drills which use a 6⅝-in. bit and are powered with 440-volt electric motors. In heavy ore, the present practice is to use a 15-ft. burden and 18-ft. spacing of the holes. In lighter ground, the same burden is used, but the spacing is then increased. Burdens greater than 15 ft. leave an unbroken toe and increase the back-break. All holes are drilled 4 ft. below the toe of the face. The footage obtained per drill shift varies from 8 to 20 ft., depending upon the hardness of the ore and rock, and also dependent on the same condition is the penetration per sharpening of a bit, which varies from 2 to 4 ft.

Blasting of drifter and wagon-drill holes is done with 60 per cent dynamite, using 1½ by 8-in. cartridges. Well-drill holes are loaded with 5 by 24-in. cartridges, using 200 lb. of 90 per cent straight gelatin dynamite at the bottom followed by 150 lb. of 75 per cent straight gelatin dynamite, with a deck load of 50 lb. of 90 per cent straight gelatin dynamite placed 15 ft. below the collar to shear the face. All holes are tamped with mill tailing. A 15 by 18-ft. spacing of the holes with a 400-lb. load of dynamite gives 0.87 cu. yd. of broken ore per pound of dynamite. With ore densities ranging from 7 to 10 cu. ft. per long ton, from 3.36 to 2.35 long tons of ore are thus broken per pound of powder. An 18 by 18-ft. spacing with a 400-lb. load of dynamite yields 1.05 cu. yd. per pound of dynamite, or from 2.84 to 2.36 long tons of ore per pound of dynamite, where ore densities range from 10 to 12 cu. ft. per long ton.

Broken ore is loaded by two shovels, powered with electric motors at 2300 volts, and equipped with 2½-cu.yd. dippers. Power is supplied to the shovels by 1500 ft. of trailing cable connected to transmission lines running across the northern and southern ends of the mine benches. In addition to the electric shovels, a Diesel-powered shovel is available with a 1½-cu.yd. dipper; it is used primarily for development work on account of its greater mobility and its ability to work on narrow benches.

Pieces of ore too large to be sent to the crusher are laid aside by the shovels for secondary drilling with jackhammers and blasting with 40 per cent dynamite. The system of joint planes in many portions of the ore is responsible for the production of a considerable amount of this oversized material.

Ore is hauled to the crusher and waste rock to the dumps in six 15-ton and two 27-ton trucks of the end-dump type. All the truck bodies are lined with heavy angle iron to withstand the impact and abrasion of the ore. With the exception of the roads from the lower benches, the mine haulage roads are laid out at a 10 per cent grade,

curves having a minimum radius of 50 ft. The trucks deliver ore to a hopper above the primary crusher, 500 ft. from the southern end of the ore body. The truck dumping point is at elevation 1806; the lowest mine bench is at elevation 1768; therefore, with the exception of ore from the 1768 and 1803 elevations, all the ore is hauled downgrade to the crusher. Waste dumps are located at the northern end of each bench outside the limits of the ore body.

At present, the average daily production of crude ore is 3300 long tons analyzing 16 per cent TiO_2 and 33 per cent Fe. In addition to the loading of ore, it is necessary to handle approximately 15,000 cu. yd. of waste rock per month. The rock comes partly from barren areas in the ore body and partly from haulage roads driven in rock.

Winter weather conditions play an important role in the operation of the mine. For January and February, 1943, the average minimum temperature was 0.9°F., and the lowest was —38°F. at the plant office. Such conditions necessitate constant plowing and sanding of mine haulage roads. The spring break-up, summer thunderstorms, and the autumn rains also intensify haulage problems. A motor grader and several bulldozers are used for the maintenance of haulage roads, benches, and dumps.

In common with many operations engaged in the war program, the mine suffers from a shortage of labor. The current mine payroll is approximately 60 men.

Concentrating the Ore

As previously stated, MacIntyre ore contains ilmenite, magnetite, and the gangue minerals feldspar, hornblende, pyroxene, garnet, and biotite. Concentration is therefore concerned with the production of (1) ilmenite concentrate, (2) magnetite concentrate, and (3) tailing containing the gangue minerals.

The mill flowsheet (see accompanying cut) was based on the results of tests on various samples of MacIntyre ore conducted over a period of many years by Charles E. Locke. Most important of the metallurgical characteristics affecting general plant design, are:

(1) Economic liberation of the minerals is obtained at 20 mesh.

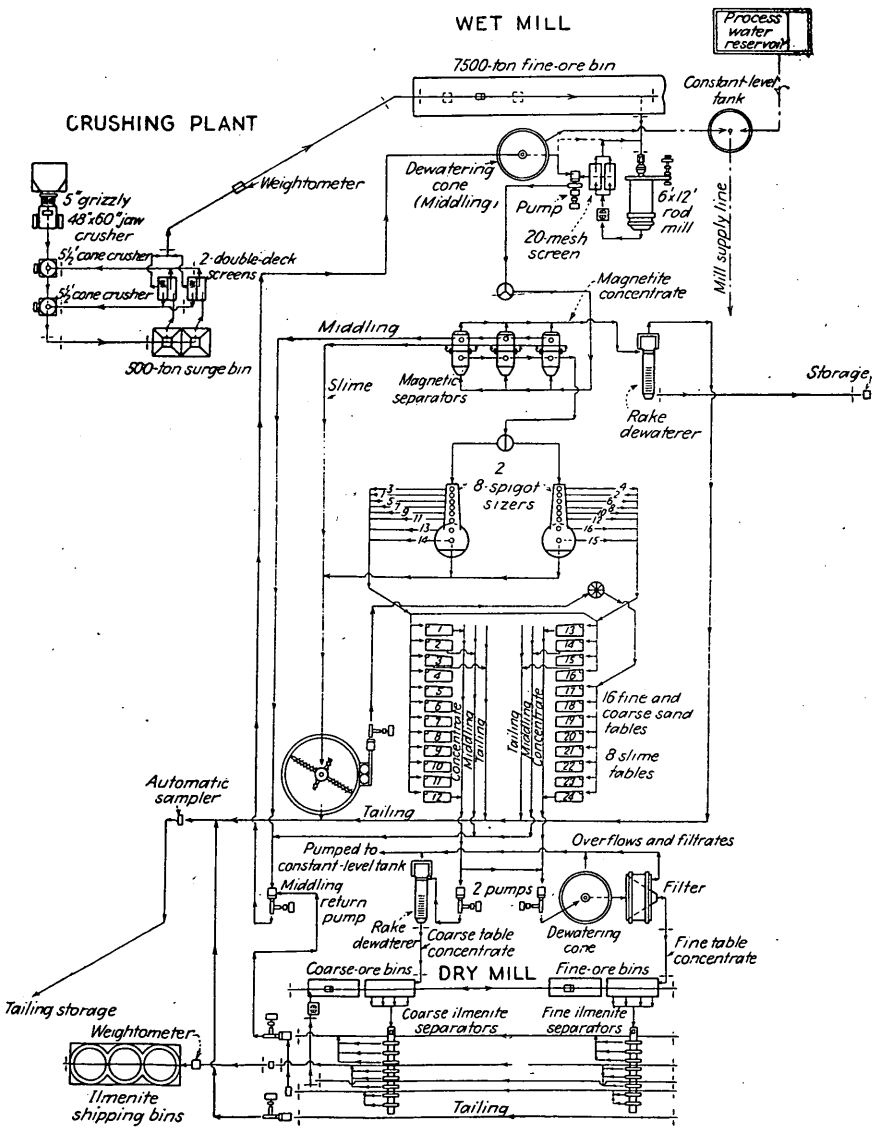
(2) The magnetite, highly magnetic, can be recovered in a concentrate of good grade, using low-intensity wet magnetic separators. Nonmagnetic tailing from the low-intensity separators consists of the ilmenite and the gangue minerals.

(3) Ilmenite in the low-intensity magnetic separator tailing can be separated from the bulk of the gangue minerals by gravity concentration, using hydraulic classifiers and tables.

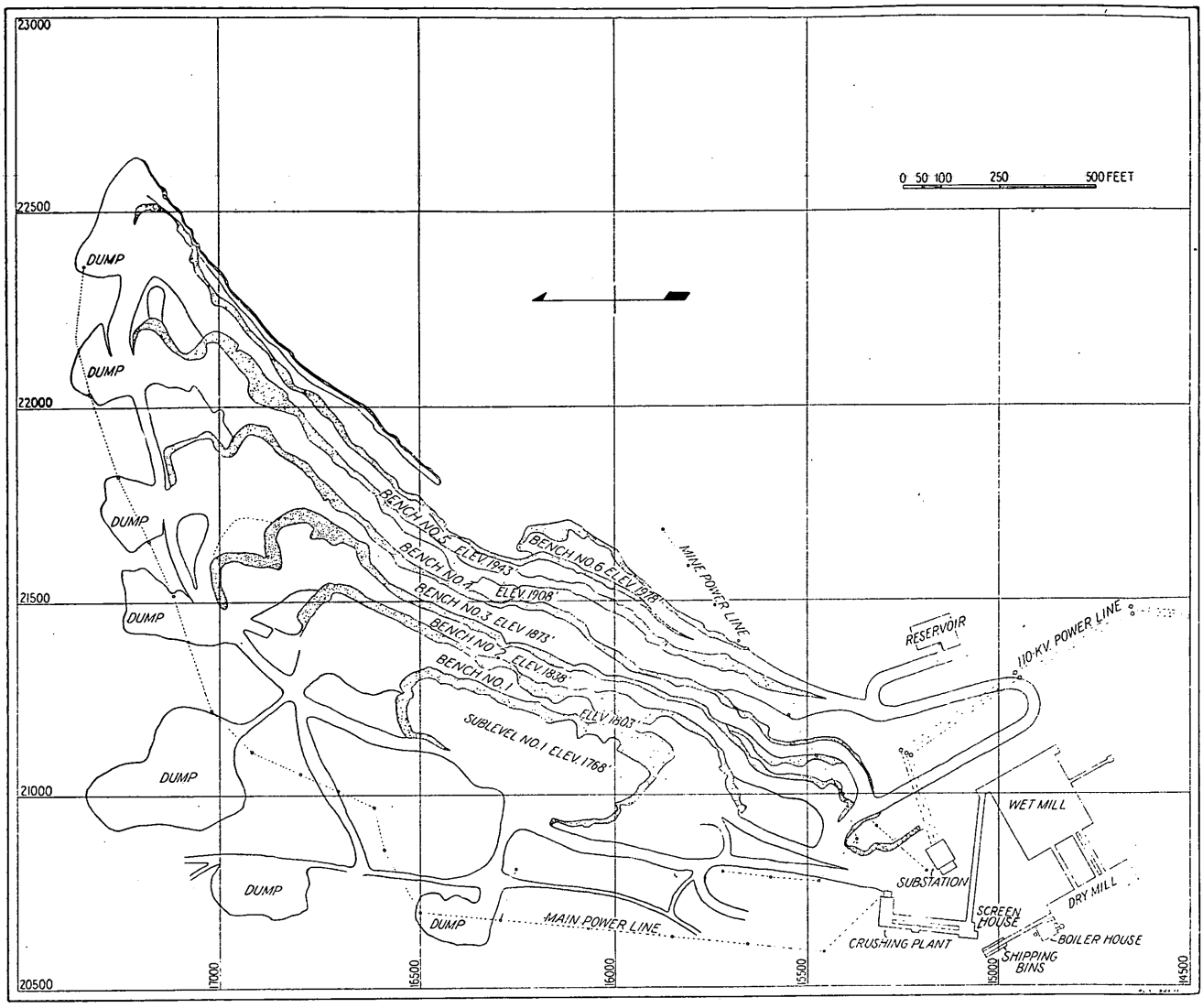
(4) The ilmenite table concentrate can be improved in grade by treatment on high-intensity dry magnetic separators with but little loss of ilmenite. The high-intensity separators reject high-specific-gravity nonmagnetic gangue which cannot be rejected in the tabling operation without excessive ilmenite loss.

The mill was designed by Archer E. Wheeler. Original plans called for one-shift ore delivery and crushing, with three parallel mill sections having a combined capacity of 2500 long tons of crude ore per 24 hours. A 33 per cent increase in mill capacity was authorized before construction started, however, so that the present mill has a capacity of 3300 long tons per 24 hours. Ore delivery and crushing is on a two-shift basis.

Ore from the mine is delivered by the trucks to a small crude-ore hopper, from which a chain-type feeder supplies a 48 by 60-in. deep-frame jaw crusher set at 5½ in. A crane-operated hook is used to assist in feeding occasional coarse pieces into the jaws. The crusher product is elevated by two 36-in. conveyors to a 500-ton surge bin from which two pan apron feeders discharge to two 5 by 14-ft. double-deck screens. These have 2½-in. square openings on the top deck cloth and ¾-in. square openings on the bottom deck cloth. Oversize from the top deck is conveyed on a 24-in. conveyor to a 5½-ft. standard coarse bowl cone crusher, set at 1 in. and the oversize from the bottom deck is conveyed on a 24-in. conveyor to a 5½-ft. short-head fine bowl cone crusher, set at ⅜ in. The products from both the standard and the short-head cone join the jaw-crusher product and go to the surge bin. Each cone is



Flowsheet of concentrating plant.



Map of MacIntyre mine on Sanford Hill ore body.

therefore in closed circuit, with the final crushing-plant product all minus ¾ in. This is conveyed over a weightometer on a 30-in. belt conveyor to a fine-ore bin, where a tripper permits proper bin distribution. A complete dust-control system is installed. An electric interlock system prevents starting up or shutting down in improper sequence and shuts off preceding equipment if a motor fails. All conveyor belts are spliced by vulcanizing in place.

In the wet mill, four 6 by 12-ft. open-end rod mills are fed by twenty constant-weight feeders that indicate and record the tonnages. The rod-mill discharge is elevated by four 38-in. belt width by 47-ft. centers bucket elevators, each having a double row of 18 by 8-in. buckets, to eight 4 by 10-ft. single-deck screens equipped with stainless steel screen cloth having a 0.05 by 0.25-in. opening. Screen oversize returns by gravity to the rod mills for regrinding while the screen undersize is pumped to distributors ahead of the low-intensity magnetic separators (Crocketts). Rod-mill grinding is at 65 per cent solids. Sprays are used to assist the bucket elevator centrifugal discharge, and overflow water boxes supply a gentle spray action on the vibrating screens.

Screen undersize at about 40 per cent solids is split to twelve 48-in. Crockett magnetic separators, which produce:

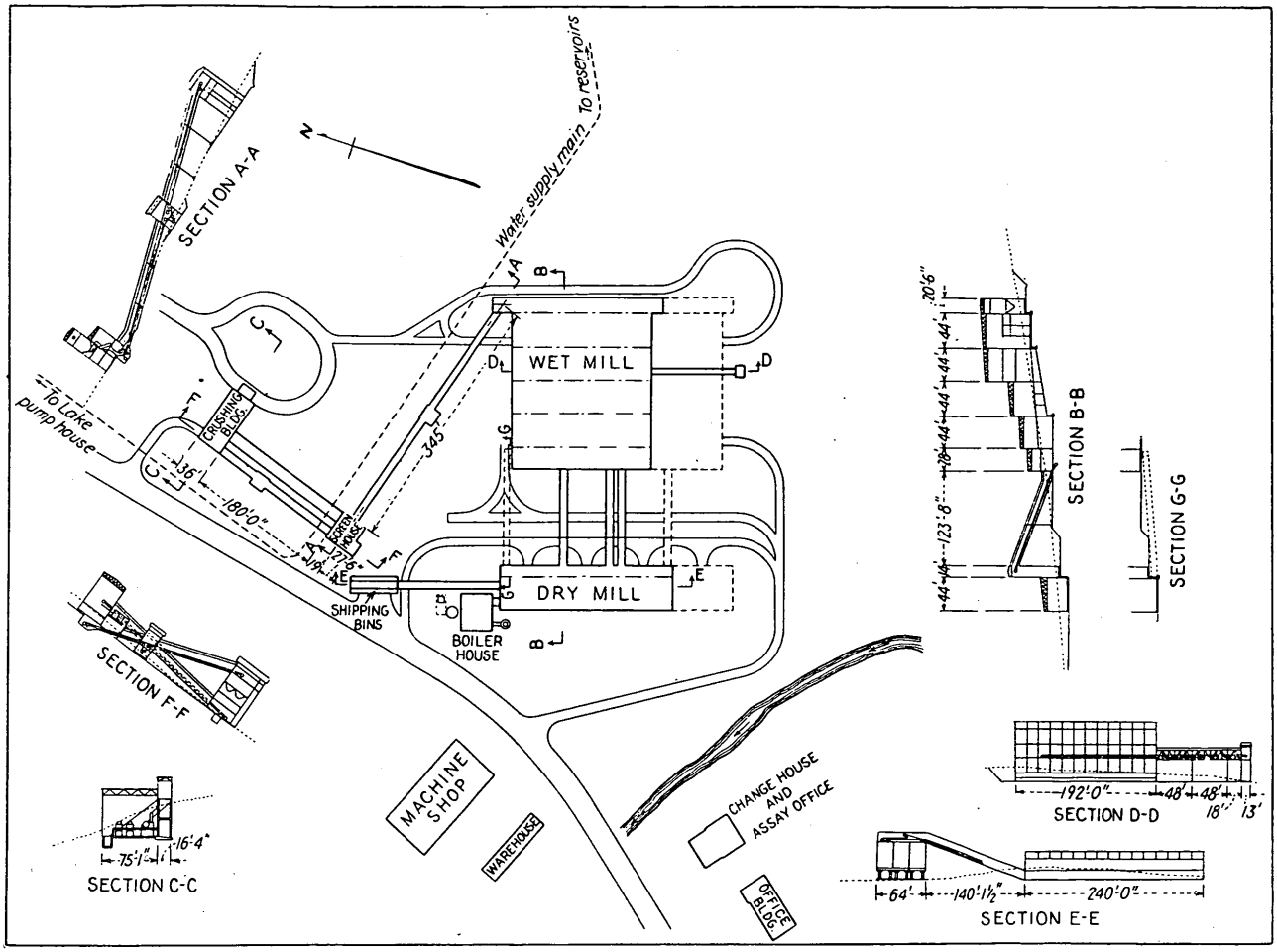
(1) magnetite concentrate
(2) middling
(3) tailing
(4) slime overflow.

The magnetite concentrate is dewatered to about 15 per cent moisture in four 4-ft. wide by 25-ft. long rake dewaterers, and is then delivered by belt conveyor to a stock pile. Crockett middling is merely returned for retreatment.

TAILING from the Crockett separators goes to eight hydraulic sizers, each having eight sand pockets. Feed to the sizers varies from 40 to 50 per cent solids. Each sand spigot discharges a classified product to one of 64 sand tables. The feed to the sizers amounts to about 62 per cent of the original mill feed.

Overflow slime from both the Crockett separators and the sizers flows by gravity to four 22 by 7-ft. hydroseparators where most of the slimed gangue minerals are removed with the overflows. The settled solids are removed by 4-in. diaphragm pumps which deliver to 3-in. sand pumps at about 42 per cent solids. The sand pumps elevate the pulp to four 8-way revolving distributors, with gravity flow to 32 slime tables.

Each concentrating table in the plant produces a concentrate, middling, and tailing, which are collected in launders beneath the table floor. Table tailing is sent to waste, discharging by launder into Lake Sanford. Table middling, together with the Crockett separator middling, is collected and pumped to 12-ft. cones installed above



MacIntyre concentrating plant, general layout.

the rod mills, which discharge to the pumps taking the screen undersize from the grinding units. The total middling return amounts to from 20 to 25 per cent of the mill feed tonnage and does not require additional grinding.

The tables are operated to produce a 37 to 38 per cent TiO_2 concentrate, as this grade proves most economical for the average mill head. It is difficult to distinguish ilmenite from the other dark minerals on the tables, so that the adjustments of the tables are partly controlled by using the previous day's assays as a guide.

Coarse table concentrate, consisting of concentrate from the first four sand tables on each section made from the first two sizer spigots, is dewatered in a 5 by 25-ft. rake dewaterer to 13-15 per cent moisture. The dewaterer overflow is returned to the constant-head tank for the sizer hydraulic water supply and the rake product of table concentrate is transported by means of an inclined conveyor belt to two dryers. Four sand pumps elevate the coarse concentrate to the dewaterer.

All the concentrate made from the remaining tables is collected by four 3-in. sand pumps and pumped to two 10-ft. cones equipped with valved rubber spigots, feeding two 4 by 10-ft. vacuum filters. These discharge table concentrate at 8 per cent moisture to two inclined belt conveyors which deliver to four concentrate dryers.

The six concentrate dryers mentioned utilize steam coils for heating; each has charging hoppers above the coils and a dry storage bin below. The dryers are installed in a separate building, together with the dry magnetic separation equipment.

THE dry concentrate storage bins under the dryers feed by gravity, through tubes, to 20 Wetherill magnetic separators, each having eight take-off belts for four coils. The first two take-offs remove the residual magnetite not extracted by the Crockett separators, the next five belts recover the ilmenite, and the last belt product is a middling. Each machine has the feeder set to treat from 2 to 2½ tons per hour.

Final ilmenite concentrate averages about 45 per cent TiO_2 and is delivered by belt conveyors to three storage bins, each of 500 tons' capacity. The final conveyor includes a weightometer. At present, the concentrate is transported from the bins to the railroad at North Creek by truck.

Under the Wetherill floor are five collecting belt conveyors for the Wetherill products. One for the concentrate, one for the magnetite, two for middling, and one for the Wetherill tailing. The tailing is collected and pumped to the tailing launder in the wet mill by a 3-in. sand pump. Part of the middling and all of the magnetite from the Wetherills are pulped with water and pumped to the table middling pump boxes in the wet mill by means of another 3-in. sand pump. The other part of the middling and some spillage material are conveyed to a bucket elevator which discharges into No. 1 dryer bin.

Steam for the dryers and for plant heating is generated by two 500-hp. 3-drum low-head bent-tube boilers equipped with single-retort underfeed stokers burning double-screened pea coal. Coal supplied to the stokers is delivered from a 200-ton silo-type bin, with a chain-bucket elevator for charging. Steam pressure for the dryers is maintained at 130 lb. and about 50 lb. of coal per dry ton of dryer feed is consumed

Metallurgical Problems

IN most gravity concentration crushing, fine-grinding, and classification are of major importance in obtaining optimum grade and recovery of the valuable mineral constituents of an ore. However, once the degree of fineness is established at which the maximum amount of values is liberated from the gangue, the fineness of grind may vary within a reasonable range without seriously affecting the grade or recovery of the mineral.

At MacIntyre, the ore-reduction problem for gravity concentration is not so simple, as there are several factors, each of which, from the point of view of fineness of grind, requires special attention. In the first place, the grind must be such that both the ilmenite and magnetite are liberated from the gangue and from one another, thus enabling the wet magnetic separators (Crocketts) to remove the optimum amount of magnetite from the ore pulp at the maximum iron grade and minimum ilmenite content. The fineness of the ore particles for the wet magnetic operation is, however, limited by the particle size which in the subsequent tabling operation gives maximum titanium grade and recovery in the table concentrate. The size range of the grains of ilmenite and gangue in the table concentrate is limited, as too great a variation in particle size of the feed to the Wetherills or dry separators will give a low-grade ilmenite concentrate or a high tailing loss from these machines.

The present metallurgical mill results are obtained with the various mill products at the screen sizes shown in the accompanying table.

WITH the degree of liberation established, the next three steps (1) Crockett separation of magnetite, (2) gravity separation of a rough ilmenite concentrate from Crockett tailing, and (3) cleaning of the rough ilmenite concentrate on Wetherill magnetic separators can be considered separately. The first concentration step, Crockett separation, is relatively simple. A good recovery of the magnetite in clean concentrate is readily obtained. Gravity concentration presents many problems, however, because the specific gravities of the gangue minerals approach that of the ilmenite. Thus, specimens of garnet show a 4.0 specific gravity, whereas the hornblende and pyroxene have gravities ranging from 3.3 to 3.7, compared to 4.5 to 4.6 for ilmenite. Close classification and careful tabling is essential for good results. Because of their relatively high iron content, the high-specific-gravity gangue minerals, which contaminate the table concentrate, are nearly as magnetic as the ilmenite; in fact, some specimens of garnet are more magnetic. Close regulation of the Wetherills is therefore required.

In the crushing and grinding operations, a certain amount of extremely fine sizes and slime is produced which together with the primary slime accounts for some 20 to 30 per cent of the total mill feed tonnage. This fine material is classified out of the sand or main circuit in the Crockett and sizer overflows and is treated on slime tables. From the start of the milling operation, the slime load has been greater than originally anticipated and the slime tables have therefore been overloaded to a considerable extent, with a resulting poor slime-table recovery. This loss has been somewhat offset by metallurgical improvements in the sand circuit. An urgent current metallurgical problem is that of increasing the recovery in the slime section. Recent flotation test results indicate that this slime probably can be treated efficiently by flotation, producing a final concentrate of marketable grade without Wetherill cleaning.

Power and Maintenance

Purchased power supplies electric energy to approximately 400 motors varying in size from 450 to 1/16 hp. with a combined demand of 3500 kva. This involved building a 41-mile 110-kv. power line on extremely mountainous and rugged terrain. It terminates at a steel outdoor substation serving three 2500-kva. transformers which step voltage down to 2400 volts. The secondary bus of the outdoor substation is solidly connected to the bus of the 2400-volt switchgear, which latter consists of eight metal-clad indoor feeder units housed in a cement-block building adjacent to the outdoor substation.

EACH feeder-unit oil circuit breaker is rated at 15,000 v., 600 amp., with a maximum interrupting capacity of 25,000 rms. All panels are equipped with integrating watt-hour meter, selective ammeter switch, and power factor meter switch. The power factor and volt meters are mounted on a swing bracket at one end of the switchboard.

All feeder cables leave the switch house in underground conduit to junction boxes outside of the building where they connect to 3-conductor 5000-volt double-braid weatherproof cable suspended from stranded galvanized steel messenger cable, with the exception of the mine and lighting circuits which are standard pole line construction. Each switchgear unit controls one section of the operation as shown on p. 516.

TABLE I. SCREEN ANALYSES OF MILL PRODUCTS AND INTERMEDIATE PRODUCTS

	Per Cent	*Per Cent Accumulative Screen Sizes*						
	Weight	*+35*	*+48*	*+65*	*+100*	*+150*	*+200*	*—200*
Rod-Mill Feed (new)	100	86.9	89.3	91.5	93.5	95.0	96.4	3.6
Rod-Mill Discharge	136	26.4	41.3	54.6	67.0	75.3	81.4	18.6
Screen Oversize	36	93.6	97.9	99.1	99.5	99.6	99.7	0.3
Screen Undersize	100	22.3	34.9	47.8	59.8	69.8	77.0	23.0
Middling Return (Crockett & Table)	25	17.5	31.5	44.5	57.0	67.3	80.0	20.0
Crockett Feed	125	20.3	35.3	49.7	63.0	72.1	79.2	20.8
Magnetite Conc't.	27	40.0	54.2	66.3	75.3	81.9	86.4	13.6
Crockett Slime (To Hydroseparator)	12	0	2.8	6.0	7.1	11.8	19.8	80.2
Crockett Tailing (Sizer Feed)	86	29.8	42.0	54.5	66.3	76.7	83.6	16.4
Sizer Slime (To Hydroseparator)	17	0	0.7	4.7	17.6	35.9	58.0	42.0
Sand Table Feed[1]	69	....	....	....	....	....	....	....
Sand Table Conc't.	17	24.4	47.6	63.8	84.4	92.5	97.0	3.0
Sand Table Tailing	34	43.0	60.1	75.5	90.1	95.2	96.9	4.1
Hydroseparator Feed	29	0.5	1.4	4.2	10.6	23.1	40.1	59.9
Hydroseparator Overflow (to Mill Tailing)	2	0	0	0	0	0	1.0	99.0
Slime Table Feed (Hydroseparator Underflow)	27	0	0.3	2.4	9.6	23.4	42.7	57.3
Slime Table Conc't.	1	0	0.2	1.2	12.0	21.4	47.8	52.2
Slime Table Tailing	20	0	3.1	6.6	14.9	29.0	44.8	55.2
Wetherill Ilmenite Concentrate		15.6	31.3	49.9	66.9	81.1	90.5	9.5
Mill Tailing	56	10.4	20.0	32.3	45.5	57.6	67.0	33.0

[1] Combined sizer spigots.

(1) Mine
(2) Water-supply pumps
(3) Dry crushing
(4) Wet grinding
(5) Wet mill
(6) Motor-generator sets
(7) Dry mill and shop
(8) Lighting.

The major mine equipment consists of:

Electric shovels
Electric-driven well drills
Diesel and electric-driven air compressors
Diesel-powered end-dump mine trucks.

Electric-driven mine equipment is served by a 2400-volt 4/o four-conductor weatherproof line connecting at a junction box near the switch building. This line is approximately 4000 ft. long and surrounds the mine on three sides. It is placed as close to the mine area as blasting will permit. Transformer stations stepping the voltage down to 440 volts are placed so that the 440 secondary lines do not extend more than 1000 ft. from transformer to cable taps. Outdoor air switches, fuses, and lightning arresters provide protection for each trailing cable and for the substations.

Ten 1-in. by 12-ft. copper-clad rods grouted with copper sulphate into holes in the magnetite ore body provide an excellent ground for transformers, lightning arresters, and other substation equipment. The fourth wire of the mine circuits paralleling the power wires is a ground wire for all mine equipment. This wire is tied solidly to all grounds and to the ground wires and conductor shields of the trailing cables which in turn are used to ground the equipment. As a further precaution, a ground rod is driven at each line tap where cable connections are made.

Two plant water-supply pumps of 5000 g.p.m. each are driven by 450-hp. synchronous motors. Power is supplied to the motors at 2400 volts through 5000-volt, 4/o three-conductor underground cable. The pumps are automatic in operation and are controlled by altitude gauges at the main reservoir. Instrument control between pumps and reservoir is through a No. 10 8-conductor rubber-covered underground cable laid in a trench with the 24-in. pipe line and power cable. An alarm system is arranged to signal if water in the reservoir exceeds either the high or low limits. Pumps run unattended except for periodic daily inspection.

All motors under 100 hp. are 440-volt. The larger motors are all 2300-volt synchronous motors with the exception of those driving the primary crushers which are wound-rotor induction motors. Motor-generator sets, main water pump, and the rod mills driven with synchronous motors constitute 40 per cent or more of the total load. These are all 80 per cent power factor motors. By proper field adjustment, it has been possible to maintain an overall load power factor of better than 90 per cent.

A bank of three 100-ampere step-type feeder voltage regulators with 10 per cent buck or boost maintain uniform feeder voltage on lighting circuits of mill and village.

Electrical and mechanical maintenance and installation work is centered at the repair shop, which is equipped with lathes, drill presses, shapers, hydraulic presses, forge steam hammer, universal iron worker, woodworking and other equipment.

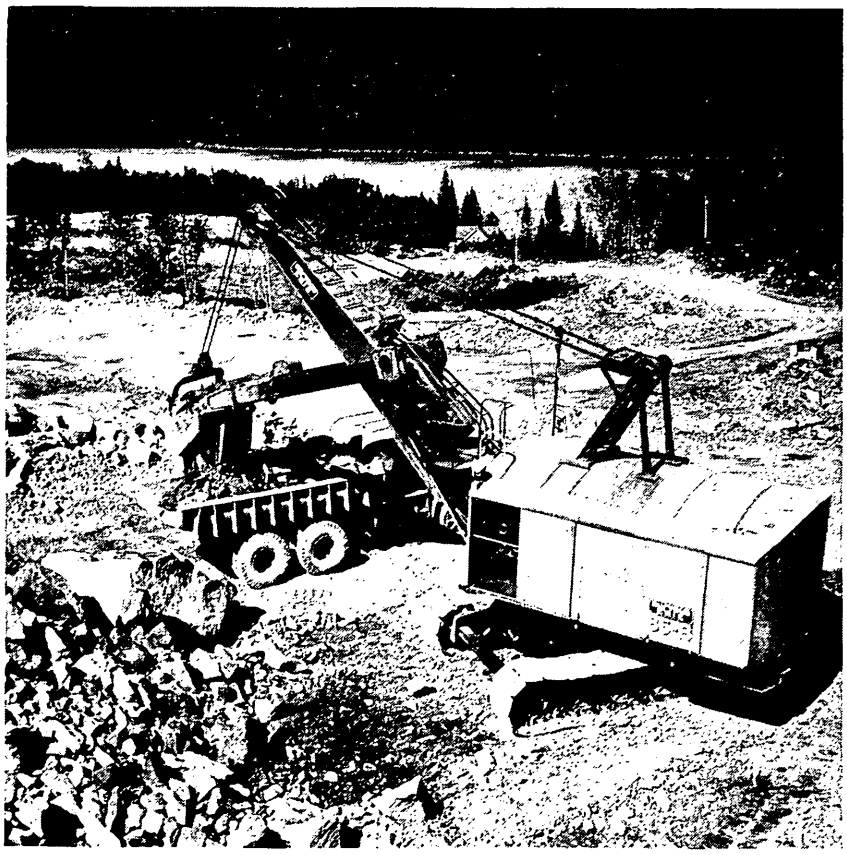
Cutting and welding by gas torch together with arc welding play a stellar role in maintenance of mine and mill equipment. One 400-ampere motor-generator welding unit and a 300-ampere portable unit are located at the shop. The portable unit is often taken out on the job. An additional 300-ampere motor-generator welding unit is placed at a central location in the mill with permanently located welding lines extending through the mill and to the shop. By a system of switches, this unit can be used in the shop, or two units can be used in the mill without transporting and connecting up the portable unit. The system has proved its worth as a timesaver, for many of the small welding jobs are done in less time than is required to move the welding equipment.

The extremely abrasive nature of the ore has placed a heavy burden on maintenance. Feeder chutes to crushers and conveyors, and transfer points, were all originally lined with manganese steel plate but in many places the lining is extremely short-lived. Building up worn plates and hard surfacing by arc welding, either in place or at the shop, have proved profitable. Repointing shovel teeth and bulldozer blade repairs take up the time of one welder.

Maintenance, by the types of equipment served, naturally falls into four major divisions:

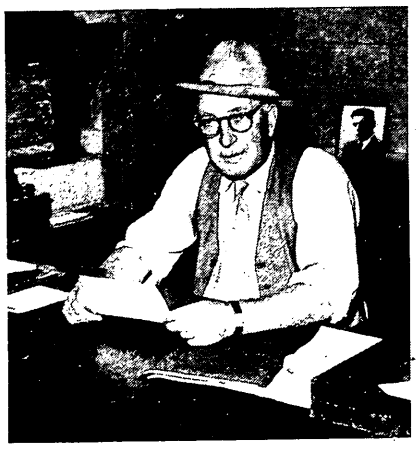
(1) Electric
(2) Mill
(3) Mine equipment
(4) Automotive.

To correlate the work of the various maintenance departments, operating superintendents or foremen notify the master mechanic's office of repairs needed or of contemplated changes. Work is then scheduled each day for the various maintenance foremen, as men, materials, and equipment are available.



Loading ore from the open pit with Sanford Lake in the background.

Development and Operation of Clifton Mines, Hanna Ore Co.



By Guy B. Hunner
Superintendent, Clifton Mine Division, Hanna Ore Co., Inc.; Member, A.I.M.E.

THOSE magnetite ore bodies comprising the Clifton Mines are situated in the south central part of St. Lawrence County, New York, on the western slope of the Adirondack Mountains. The topography is made up of gently rolling hills densely wooded with second-growth maple, birch, and hemlock. Drainage is north and west to the St. Lawrence River.

Evidences of an early operation at this site were indicated by a large brick stack adjacent to the ore body, standing 160 ft. high and dated 1868. Small pits and short tunnels, in which were unearthed crude mining tools, gave evidence that this operation was short-lived. Old timers, however, recall a narrow-gauge railroad running from the property north to DeKalb Junction on the New York Central Railroad. Probably not over 10,000 tons of ore was removed during this operation.

In 1940 magnetometer surveys and diamond-drilling had proved a commercial ore body warranting a sizable operation and in July 1941 The M. A. Hanna Co., of Cleveland, decided to develop the property.

Due to the inaccessibility of the ore body it was necessary to construct telephone lines, power lines, highways, and railroad tracks before actual development could start. This work was pushed with all possible speed to bring the plant into production and help meet the increased demand for iron ore.

Temporary headquarters were established in an old hotel building in the hamlet of DeGrasse and all construction work was directed from this point. A rough trail was cleared through 5½ miles of heavy timber to the proposed plant site and tractors and teams transported lumber and cement for the first stages of construction. Meanwhile, gas shovels, bulldozers, and trucks were completing the highway along the route of the original trail. The preliminary survey for this highway followed a foot-path through the woods which is indicated on maps published in 1865 as the Lake George Road. Local historians advise that this was a military highway used during the War of 1812 to move troops from Lake George to the St. Lawrence River.

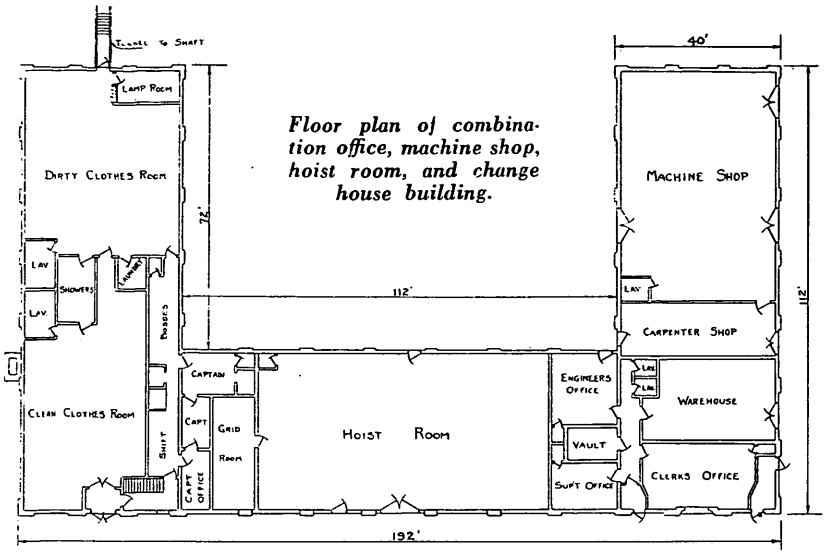
In order to have outside communication from the temporary headquarters in DeGrasse it was necessary to build approximately fourteen miles of telephone line from the village of Edwards. This line was later extended to the plant site where the Worden-Allen Co., of Milwaukee, had erected a temporary field office and commissary preliminary to the start of construction on the plant buildings.

Simultaneously with the above work, the Acme Construction Co., of Cleveland, started construction of a twelve-mile railroad track from Newton Falls to the mine. In the first stages of this work it was necessary to bridge the Oswegatchie River. Stiff grades and heavy cuts and fills were encountered in climbing the Oswegatchie valley and skirting the impounded waters of the river above the dam of the Newton Falls Paper Co. On Dec. 22, 1941 the first train arrived at the mine carrying structural steel and mill machinery for which the foundations had been poured during the fall and early winter months.

Previous to the completion of the railroad, the timber and shallow overburden covering the ore body had been removed and rock-stripping operations started. Surface trenches and diamond-drill cross sections indicated an economical open-pit operation to a depth of approximately 120 ft. below the crest of the ridge through which the ore body ran. Due to the angle of the dip of the deposit—about 45°—the hanging-wall rock had to be cut back parallel to the ore body to provide a vertical pit wall on the hanging-wall side. A 3½-cu.yd. electric shovel and four 6-in. electric blast-hole drills were unloaded at Oswegatchie station on the New York Central Railroad and trucked 22 miles to the mine. To accomplish this over country roads it was necessary to reinforce several bridges and culverts. During this period eight miles of power line were constructed from the Brown's Falls power plant of the Central New York Power Corp. on the Oswegatchie River.

Stripping operations were carried on during the winter of 1941-1942. Meanwhile, the original mining equipment had been supplemented by a Diesel-powered shovel with a 2½-cu.yd. dipper, five wagon drills mounting 4-in. drifters, and five 15-ton rear-dump trucks.

While stripping operations were in progress, construction of the primary



Floor plan of combination office, machine shop, hoist room, and change house building.

and secondary crusher buildings was being pushed through the winter and the first direct-shipping lump ore was loaded on June 3, 1942. Production of lump ore then continued. A temporary stock-pile trestle was erected and all mill-grade ore coming from the pit was sent to the stock pile after having passed through two stages of crushing. This was done so that lump-ore shipments could continue during the completion of the mill building and sinter plant. A reclaiming hopper was constructed at one end of the stock pile, this ore being reclaimed through the hopper with the aid of a bulldozer.

The benefication plant is comprised of five buildings: the primary-crusher building in which are housed the primary crusher and the reduction crushers; the secondary-crusher building housing the secondary crusher and the magnetic pulleys over which the direct-shipping lump ore is separated; the mill building, which encloses two 500-ton surge bins ahead of the wet grinding and wet separation; the pug mill; and the sinter plant. Original plans called for all plant buildings to be covered with corrugated asbestos-cement sheathing but Government restrictions forbid the use of this material when construction started, so all buildings had to be covered with corrugated galvanized sheets with the exception of the mill building which is covered as originally planned. The lower floor of the pug-mill building is constructed of brick and lined with hollow glazed tile. This portion of the building is equipped with toilets, shower baths, wash fountains, and lockers for the mill-building and sinter-plant employees.

Offices, shops, engine room, and miners' change rooms are housed under one roof in a U-shaped brick building also lined with hollow glazed tile. This building is 192 ft. across the front. Both wings of the U are 112 ft. deep with a cross-sectional width of 40 ft. in each wing. The east wing from front to rear comprises the clerical offices, No. 1 warehouse, carpenter shop, and machine shop. The front center section of the building houses the superintendent's office, engineer's office, and the hoisting-engine room. Two air compressors, a double-drum ore hoist, and a single-drum cage hoist are located in this room which is on the center line and approximately 220 ft. from the shaft.

The west wing from front to rear is given entirely to miners' change rooms for the underground operation. In the front portion of this wing the oncoming shift enter an air-conditioned room where they leave their street clothes on hooks and baskets which are hoisted to the ceiling. The shift then passes through a one-way door to the working-clothes room where their mining clothes are also hanging on baskets and hooks suspended from the ceiling. From here they pass the lamp room where battery lamps are checked in and out and recharged. From the lamp room a door leads down a short flight of enclosed stairs to a rock tunnel which leads to the cage entrance at the shaft. Doors are arranged in the change rooms so that a miner coming off shift cannot pass from the mining-clothes room into the clean-clothes room without entering the shower room. A wash fountain is provided in the mining-clothes room for miners to wash their hands when coming to the surface for lunch.

Both rooms are equipped with toilet facilities so that it is unnecessary to pass from one room to another except when coming in or going off shift. Air-conditioning is provided in both change rooms. Incoming hot air enters through air ducts near the ceiling and after circulating through the clothes hangers is drawn off through exhaust ducts in the floor. Laundry tubs are provided in a small room adjacent to the mining-clothes room. The shift bosses and mining captain have similar change-room facilities in a portion of the building between the miners' change rooms and the engine room. Here also is the mining captain's office. Water for drinking and bathing purposes is supplied from a gravel wall well near the plant.

In July 1942, sinking operations were started on a 13 by 15-ft. vertical shaft which is now being cut out on the first level at a depth of 270 ft. below the collar. The shaft is comprised of six compartments, two skips, cage, ladder road, pipe, and cage counterweight. Steel shaft sets are used, spaced on 6-ft. centers, and concrete walls are carried down 30 ft. from the collar where entrance is made to the cage through the tunnel from the change house. Present plans call for the underground operations to start in the spring of 1944.

In connection with the start of plant construction in the fall of 1941, the company began the construction of eight modern staff houses in the hamlet of DeGrasse. Here again it was necessary to develop a water and sewage disposal system and extend power and telephone lines. In addition to these houses the hotel building, used originally as a temporary headquarters, was converted into a rooming and boarding house for clerical employees. No provision has been made to house such labor as is recruited within a radius of twenty miles of the operation. Of the approximately 175 men employed in the mine and plant, most came from small farms in the district and were entirely unfamiliar with a mining or milling operation. Months of training have been necessary to develop them into skilled operators in the use of mining and mill machinery.

Due to the necessity of operating with green labor, safety education has been stressed since the start of operations. At present this work is carried on through a central safety committee composed of all department heads and all foremen. Monthly meetings are held by this group at which time all accidents reported during the previous month, whether involving lost time or not, are discussed. Safety suggestion boxes, supplied with pencil and note paper, are posted in conspicuous places about the property and all employees are encouraged to help the safety program with their suggestions. These are studied by the committee and acted upon immediately. Formal acknowledgement is made on the bulletin board

for every outstanding suggestion. At each meeting a new chairman is appointed to take charge of the committee and make all arrangements for the next monthly meeting. Through the cooperation of the U. S. Bureau of Mines about 30 per cent of all employees have received first-aid training.

Being isolated from state and county highways the company has had to assume all road maintenance and snow removal on the road between the plant and DeGrasse. This work is handled with a Diesel-powered road grader equipped with cab, plow, and wing attachment. In extreme cases two Diesel tractors with trail builders are used for bucking heavy snow drifts. On many occasions during winter months this equipment has been out on continuous service for more than 24 hours with relay drivers. Temperatures ranging to fifty degrees below zero, when experienced in an open-cut rock-stripping operation in New York State granite, give definite proof of a loyal crew and the ability of modern equipment to stand up and take it.

Geology of the Clifton and Parish Ore Deposits

By A. E. Walker
Geologist; Member, A.I.M.E.

SOME eighty years have elapsed since the discovery of the Clifton magnetite deposit. For a few years about the time of the Civil War it was mined for iron ore, most of which was smelted on the property. Since then the small exposures of ore in the old cut, test pits, and on the dumps have been examined by various prospectors. The M. A. Hanna Co. first became interested in the possibilities of the deposit when we discovered the large area of strong magnetic anomalies caused by the magnetite bed, indicating a size that would support a commercial operation. In 1940 we made a detailed magnetometer survey of the area, and the deposit was diamond-drilled. The main ore bed was found to be 1500 ft. long, to average 60 ft. thick, and to dip southeast at an angle of about 40 deg. The thickness of the bed is irregular in wavy folds both along the strike and down the dip. Faults occur at both ends of the main deposit.

The Clifton ore bed is a member of a series of highly metamorphosed, siliceous, sedimentary, bedded Pre-Cambrian gneisses (Grenville series), and, from what microscopic study we have made, seems to have been originally a limestone. It is now metamorphosed into its present mixture of iron ore and gangue minerals by injected hot solutions which brought in large quantities of iron. Magnetite, epidote, augite, basic feldspar (probably laboradorite), phlogopite, biotite, calcite, and dolomite occur in the ore-bearing formation. A fair percentage of the magnetite is solid enough and free enough from the gangue minerals to make a high-grade direct-shipping ore product. The rest of the mixture is milled and the magnetite concentrate sintered. The quality of the ore is shown in Table 1.

TABLE 1. ANALYSIS OF CLIFTON ORE

	Mill Ore Per Cent	Lump Ore Per Cent
Fe	42.25	58.16
P	0.170	0.175
Mn	0.16	0.41
SiO_2	19.50	8.26
CaO	9.12	5.55
MgO	5.86	2.16
Al_2O_3	1.75	1.86
S	0.50	0.24
TiO_2	0.18	Trace

We have concluded that in the area of this ore deposit, the original limestone member of the sedimentary series, or at least part of it, has been highly metamorphosed and remineralized by hydrothermal solutions. These solutions introduced large quantities of iron to combine with and replace the original carbonate minerals and produce the large masses of ferromagnesian and calcium minerals now prominent, and to deposit lenses and disseminations of coarsely crystalline magnetite. Some remnants of the original limestone remain as well-crystallized calcite and dolomite marble.

TABLE 2. ANALYSIS OF PARISH ORE

	Mill Ore Per Cent	Manganiferous Ore Per Cent
Fe	39.70	55.80
P	0.065	0.026
Mn	4.70	9.92
SiO_2	23.30	7.80
S	0.030	0.261
TiO_2	0.24	0.20

Every characteristic of this deposit appears to be of igneous origin except the shape of the ore body. The important feature of this theory of replacement, however, is that for all practical purposes the ore bed now occupies the position of the original limestone sedimentary bed. Additional exploration beyond our present depth of 600 ft. down the dip is quite simple and quite sure to develop additional ore.

Another magnetite deposit on the

Shovel loading iron ore in opencut mine.

company's Parish property, which adjoins Clifton, has been surveyed and diamond-drilled. This ore differs from the Clifton type in that it appears to be replacement of the original carbonate cementing material in a sandy sediment. The ore mixture now contains a large amount of free quartz, which is probably the original sand now recrystallized, and a smaller proportion of direct-shipping solid magnetite ore. The iron oxide ore also differs from that in the Clifton deposit, which is all magnetite, by the presence of a fair amount of martite, and a considerable amount of secondary manganese. Table 2, on the preceding page, gives an analysis of this Parish ore.

Mining Methods at Clifton Mines

By F. W. Sutter
Mining Captain

IN order to have ore available on the completion of the beneficiation plant at Clifton and to provide for continuous production while underground development was carried out, it was decided to develop an open-pit through the crest of a long hill in which the ore outcropped, using 40-ft. vertical benches.

The first cut was opened from the hanging-wall side of the ore body, which has a dip of about 40° to the southeast. A narrow cut was made through the rock to the hanging-wall contact about midway the length of the ore body. At this elevation the rock was cut back each way along the contact to a stripping limit which would provide a vertical pit wall on this side when the ultimate pit depth of 120 ft. was reached.

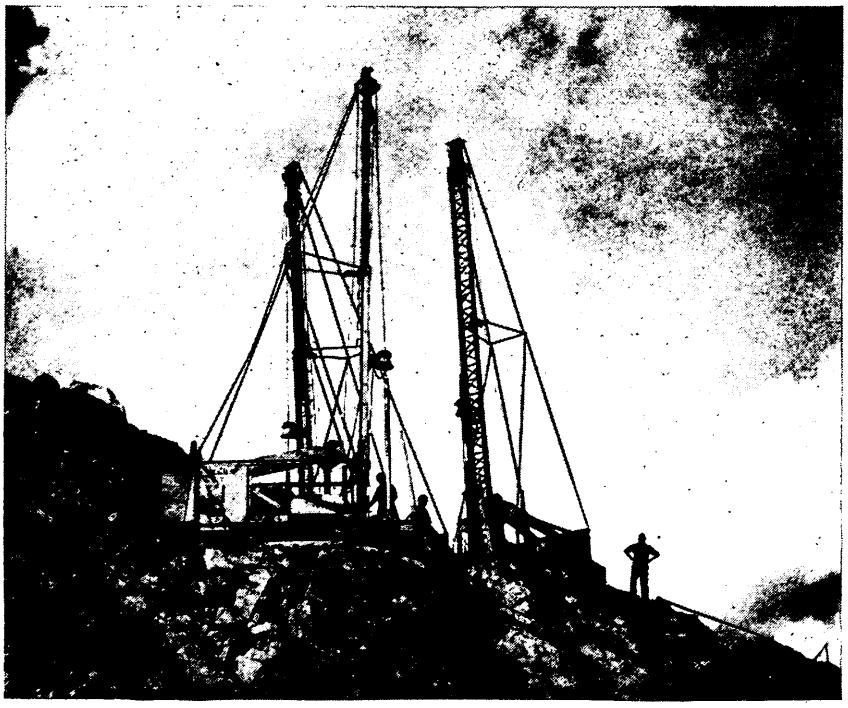
The second and present operating cut was opened midway in the ore body from the footwall side to take advantage of the natural topography. The pit approach was moved to skirt the southwestern end of the ore body and brought down the northern side of the hill to the proper elevation where entrance is made. The grade on this approach was held to 8 per cent and it was only necessary to dig and cast until the pit entrance point was reached. A narrow entrance was made through the ore body from foot to hanging and the hanging-wall rock was cut back each way along the contact to coincide with the cut above. At this elevation the hanging-wall side of the ore body makes contact with the vertical pit wall and no rock stripping will be necessary for the third cut which will be a sinking cut in ore along the footwall contact from the present pit entrance.

Primary drilling is done with four 6-in. blasthole drills, electric-powered and self-propelled by a 15-hp. variable-speed motor using 440-volt, 60-cycle, 3-phase current. Two men operate each machine. Drilling is done on two 8-hour shifts, seven days a week. The average daily total footage for all machines is 128 ft. Holes are drilled in rows across the ore from foot to hanging and parallel with the working face. The first row is drilled with a 10-ft. burden and spaced 8 ft.; the second and third rows are given an 8-ft. burden and spaced 8 ft., but are staggered 4 ft. off center from the holes in each preceding row. All holes are drilled 45 ft. deep or 5 ft. below grade unless the footwall rock is encountered, in which case the hole is stopped at the contact. An average row has four to six holes the full depth, with the rest down to the slope of the footwall rock.

Ordinarily, three rows of from eight to twelve holes each make up a primary shot. These are delayed first, second, and third in their respective positions from the face. The customary loading of a 45-ft. hole consists of placing 50 lb. of 5 by 16-inch 75 per cent special gelatin dynamite in the bottom. This is followed by 250 lb. of 5 by 16-in. 60 per cent special gelatin dynamite. Sand tamping is next added to the required level for the deck load of 50 lb. of 60 per cent special gelatin dynamite, and the balance of the hole, some 14 to 16 ft., is filled with sand. A 4-in. lead ball on a rope is used in tamping powder and sand. Six to eight men require about eight hours to load a shot. The amount of explosive in shallower holes is cut in proportion to their depth and the deck load is omitted in all holes less than 30 ft. deep. All primary shots are aided by a toe cut drilled by wagon drills across the bottom of the face. The cut is usually 12 to 18 ft. deep and bottoms slightly below grade. Holes are spaced 20 in. apart. This cut is blasted in series with the primary shot and with instantaneous detonators.

The hanging-wall face is squared up in advance of the primary shooting. This is accomplished with five wagon drills mounting 4-in. drifters. Detachable bits are used, starting with a 2⅝-in. gauge. Holes are placed 30 in. apart and drilled 18 ft. deep. The average toe cut consists of five rows of thirty holes each. It is often necessary to drill and blast the second cut in order to square this face enough for the proper burden on the primary cuts.

These holes are loaded with 1½ by 8-in. 75 per cent and 60 per cent special gelatin dynamite averaging about 7 lb. of explosive to a hole and tamped with sand-filled paper bags. The shot is delayed from the upper row to the bottom and all firing is done from a blasting switch, using either 110- or



Two blast-hole drills.

A part of the surface plant at Clifton Mines

200-volt current as required, located in a shop building a safe distance away.

Secondary drilling and blasting consists mostly of blockholing and blasting oversized chunks from the primary shots. Five jackhammer drills are used in this drilling; the average load for these shallow holes is one half stick of 1¼ by 8-in. 40 per cent dynamite using a No. 6 instantaneous electric blasting cap in each drilled hole. Maximum chunk size is 24 in.

All the material from the pit is loaded by two shovels, one electric with a 3½-cu.yd. dipper and one full Diesel with a 2½-cu.yd. dipper. The electric shovel is used for most of the ore loading and the Diesel shovel is moved to various cleanup jobs about the pit.

Five 15-ton Diesel-powered rear-dump trucks with dual rear wheels are used to transport the ore from the pit to the dump pocket at the primary crusher building, a distance of approximately 3000 ft. These trucks, with their short turning radius, have proved especially adaptable to this operation. All grades in the pit and mill approach are held to 8 per cent.

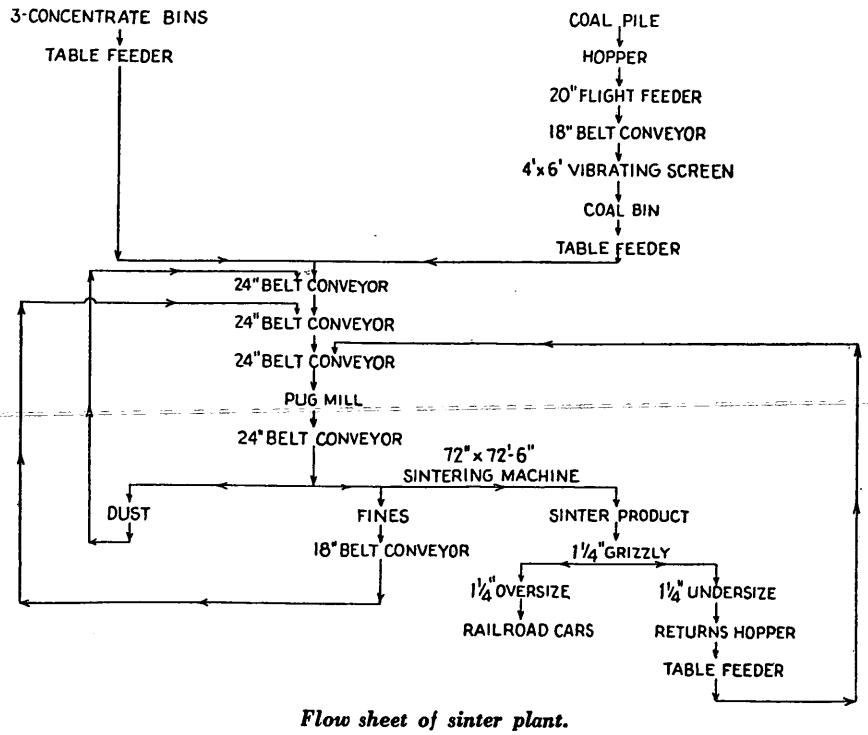
Development work for the underground operations has started on the first level. About 300 ft. of drifting will be required from the shaft to the ore body. The elevation of the first level will allow 150 ft. of back to the pit floor. Main-level haulage drifts are being driven in ore along the footwall. A sublevel stoping method for underground extraction is planned. The ore body averages 60 ft. in width and it is planned to open the stopes from hanging wall to footwall and retreat longitudinally with the strike of the deposit. Most of the ore will be drawn by gravity through grizzlies above the main-drift loading chutes. In instances where footwall irregularities are encountered, cross-haul scraper drifts with finger raises will be driven and the ore scraped directly into the cars from these raises with double-drum scraper hoists and hoe-type scrapers. Two-way air-dump steel cars of 5 long tons' capacity will haul the ore over 36-in. gauge tracks to the shaft where it will be loaded directly into 5-ton skips in balance.

The Clifton Mill and Sinter Plant

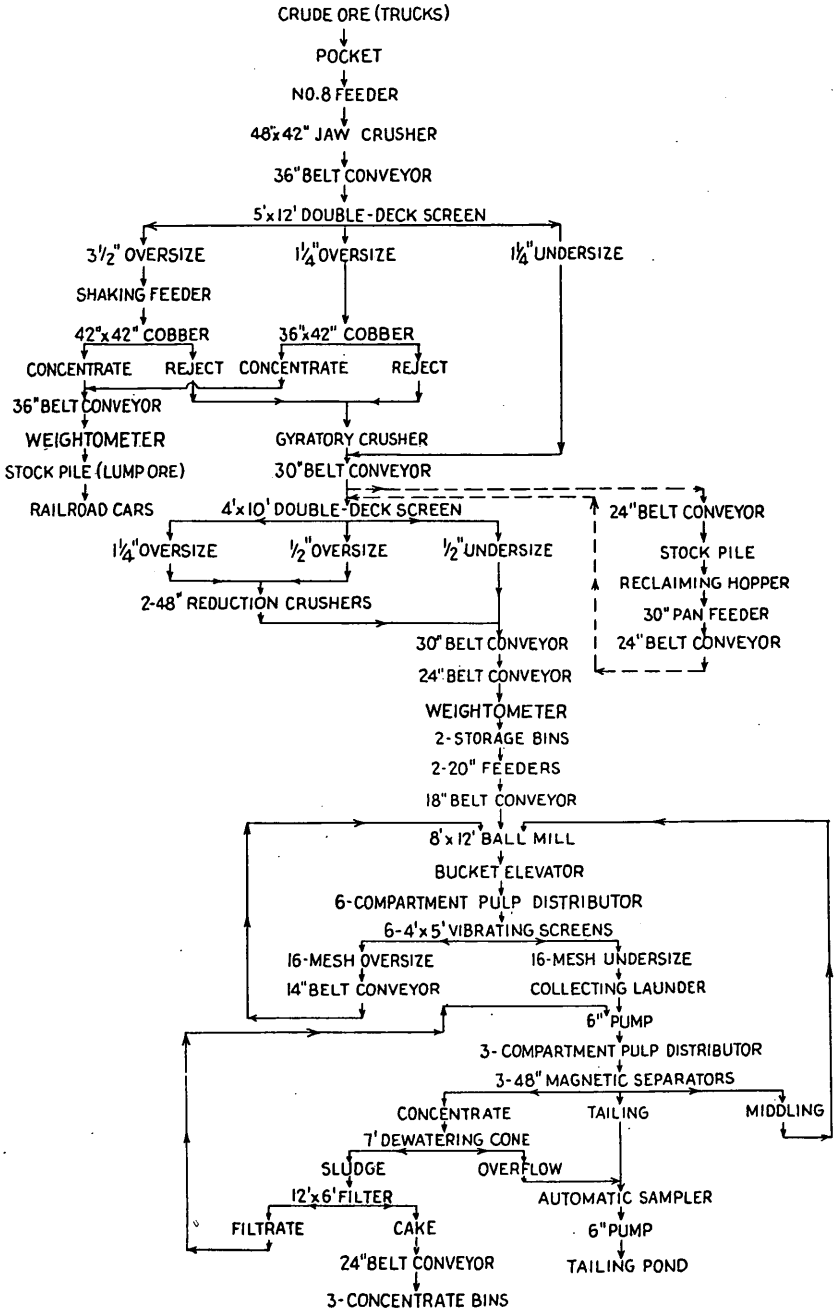
By John C. Durfee
Mill Superintendent; Member, A.I.M.E.

DAILY capacity of the Clifton mill is 1800 long tons of abrasive magnetite ore. The iron-bearing minerals are magnetite and small amounts of pyrrhotite and pyrite; the gangue mostly augite, biotite, garnet, quartz, and some calcite and dolomite. Average analysis of the crude ore milled is as follows: Iron, 42.25 per cent; magnetic iron, 35.9; silica, 19.50; sulphur, 0.50; and phosphorus, 0.17 per cent. The iron present in the nonmagnetic state is nearly all in the form of nonmagnetic sulphides or silicates.

The mill consists of three distinct operations: crushing and screening in three stages to one half inch; grinding and magnetic concentration; and sin-



Flow sheet of sinter plant.



Flow sheet of crushing and concentrating plant.

tering the finished concentrate. (See accompanying flowsheets.)

Crude ore is delivered to the mill by 10-cu.yd. trucks and dumped into a chute from where it is fed by a No. 8 chain-type feeder into a jaw crusher set at a 4¾-in. opening. After screening, plus-3½-in., and minus-3½-in. plus-1¼-in. material is fed separately to two dry magnetic cobbers. The cobber concentrate is weighed and stocked as lump ore. This product assays iron 58.16 per cent; silica 8.26; sulphur 0.273, and phosphorus, 0.175 per cent, and constitutes 20 per cent of the crude ore.

Rejects from the cobbers are crushed in a 16-in. gyratory crusher set at 2½ in. The crusher product and the 1¼-in. screen undersize are conveyed to a screen or to a stock pile. As the mine furnishes ore to the mill on only one shift a day, it is necessary to reclaim from the stock pile to supply the mill for the other two shifts. The 1¼-in. and ½-in. oversize products from the screen are crushed to ⅜ in., and owing to the tendency to produce slabs it is necessary to keep these crushers set very close to that size. The crushed material and the ½-in. screen undersize are weighed, sampled, and conveyed to two 500-ton storage bins ahead of the ball mill.

Ore is fed from the storage bins by means of constant-weight feeders to a grate-discharge ball mill in closed circuit with vibrating screens with 16-mesh openings. Grinding is done at approximately 58 per cent solids with a steel wear of 1.6 lb. per long ton of feed. Screen undersize is pumped by a rubber-lined pump to Crockett-type magnetic separators. Screen oversize, plus the Crockett middling, is returned to the ball mill.

The Crockett concentrate is dewatered in a cone with a sludge discharge to an internal-fed filter. The Crockett tailing and overflow from the concentrate cone are collected, automatically sampled, and pumped to the tailing pond by another 6-in. rubber-lined pump. Rubber cloth is used as the filter medium, which allows a small amount of fine concentrate solids to pass through, so the filtrate will average between 2 and 3 per cent solids and it is therefore necessary to return it to the screen undersize pump. The filter cake, carrying about 8 per cent moisture, is conveyed to one of three concentrate bins ahead of the sintering operation, these bins each having 250 tons' storage capacity.

Coal for sintering is anthracite No. 4 buckwheat. It is received in hopper-bottom cars and stocked during the warmer weather; then when used is loaded into a hopper from which it is conveyed to a scalping screen in the sinter plant. Undersize from the screen drops into a coal bin beside the three concentrate bins. The three ore bins and the coal bin are discharged by table feeders onto a common conveyor belt, which later has the dust and hot sinter returns fed onto it, the mixture being fed to a pug mill where it is well mixed prior to sintering.

The sinter machine is a 72-in., twelve-wind-box, Dwight Lloyd type of machine, with oil-fired ignition. Concentrate makes up 60 to 65 per cent of the mixture, fuel 4 per cent, and returns 30 to 35 per cent. The sinter pallets discharge onto a grizzly with 1¼-in. spacing. The undersize from the grizzly drops into a brick-lined returns hopper, which discharges, by means of a table feeder, onto the belt carrying the coal and concentrate mixture. Oversize from the grizzly drops into water-sprayed railroad cars. The sinter product analyzes iron 62.45 per cent, silica 4.97, sulphur 0.010, and phosphorus 0.021.

The mill water is pumped from the Grasse River, a distance of approximately two miles from the mill, by two 1000-g.p.m. pumps. Only one pump is used at a time, but they are automatically controlled so that should one pump fail for any reason the other pump will immediately start with an attendant warning at the mill. No effort is currently made to reclaim any mill water from the tailing.

Jones & Laughlin's Development at Benson Mines

By Edward H. Robie
Editor, "Mining and Metallurgy"

OF the current Adirondack iron mine development, the Benson Mines operation of the Jones and Laughlin Ore Co. (Jones & Laughlin Steel Corp. wholly owned subsidiary) is the last to go into operation. Following an active construction program in 1943, the mine, concentrator, and sintering plant were scheduled to enter production in the fall. This description therefore cannot include any operating data, and details of equipment and flowsheet have not as yet been released.

Like the operations at Lyon Mountain, Mineville, Tahawus, and De Grasse, the Benson Mines development is not based on a new ore discovery, as J. R. Linney points out in a separate article. The ore body has been known for years, and was first extensively worked in 1889, by the Magnetic Iron Co. The Benson Mines Co. operated it for a time during the first World War, and some of the ore and tailings produced at that time are still on the property. After several years of inactivity, in July, 1941, Jones & Laughlin leased 3200 acres of mineral lands from the Benson Iron Co., including the mine and adjacent property. A plant to produce 400,000 long tons of sintered concentrate a year was planned, but at Government request this was subsequently raised to 1,000,000 long tons. Financing was accomplished through a $7,000,000 Defense Plant Corp. mortgage, to be amortized in ten years.

Heretofore Jones & Laughlin, whose main steelworks are in the vicinity of Pittsburgh, has depended upon the Lake Superior district for its iron ore. Its consumption has been on the order of five million tons a year, so the present development will supply something like a fifth of the company's requirements.

Like the Clifton mine of the Hanna company, which is only about ten miles to the north, the Benson property is well to the west of the mountains, which cease to be prominent features of the landscape after one leaves Tupper Lake going west. The motorist on Route 3 cannot miss the property for it is right on the highway, 39 miles west of Tupper Lake and 2½ miles east of Star Lake, an old summer resort. In fact the roadway had to be moved a hundred yards or so to the south to permit erection of some of the shop buildings.

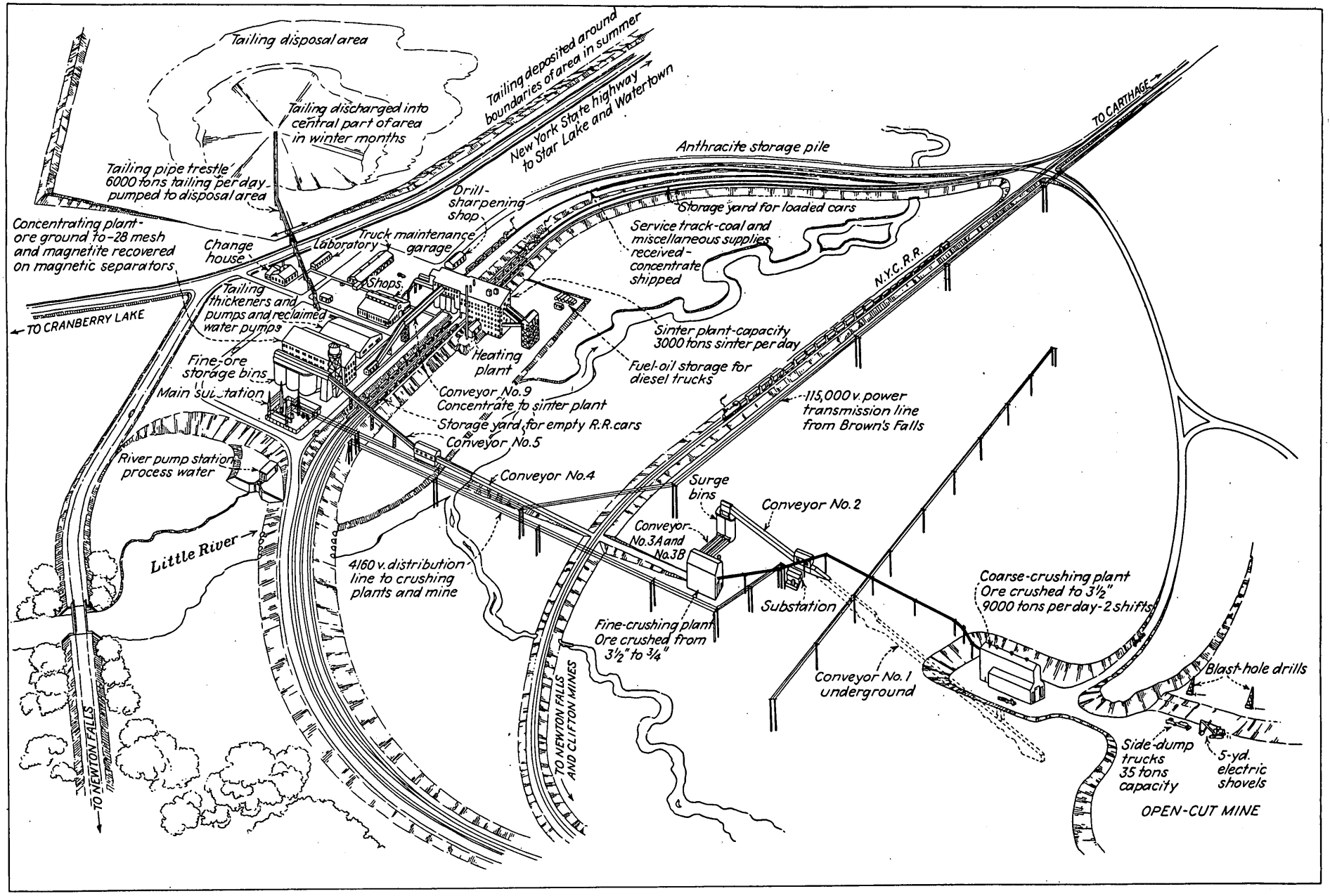
Just why the deposit was given a plural name—Benson Mines instead of Benson Mine—is not altogether clear, for the only local ore body seems to be a continuous one. Formerly two pits were worked on the outcrop, which is perhaps the reason.

For some years at least the mine will be worked as an open-pit, but the time will eventually come when resort must be had to underground mining. The ore area indicated by magnetic surveys is extensive, and drilling to establish pit limits has developed a large tonnage of ore. As mined, this will run from 25 to 30 per cent iron (pure magnetite is 72.4 per cent), which will be concentrated magnetically up to 60 to 65 per cent. The ore body is distinguished from most other

J. C. Madson, general manager

eastern deposits because it contains both magnetite and hematite, but in general the two oxides occur separately. For the time being, the hematite portion will be bypassed in mining pending investigation of methods of recovery in a test plant now being erected. The test work on which the present flowsheet is based was conducted at the University of Minnesota.

The usual bench system of mining



Perspective drawing showing arrangement of plant at Benson Mines

will be employed, the height of the benches being 40 ft., 80 to 400 ft. wide, and the pit extending some 10,000 ft. It is planned to keep four faces working at all times, three 5-cu.yd. electric shovels loading the ore into a fleet of semitrailer trucks for transportation to the crushing plant. The company pioneered with the use of trucks of this type for ore haulage on the Mesabi Range in Minnesota. Smaller shovels, of 2½-cu. yd. capacity, are used for stripping. Some 9000 long tons of crude ore will be handled daily, operating in two shifts.

By usual standards the ore would be classed as hard, as the country rock is a syenitic gneiss. Churn and wagon drills are used for drilling the blastholes, and more or less blockholing is likely to be required.

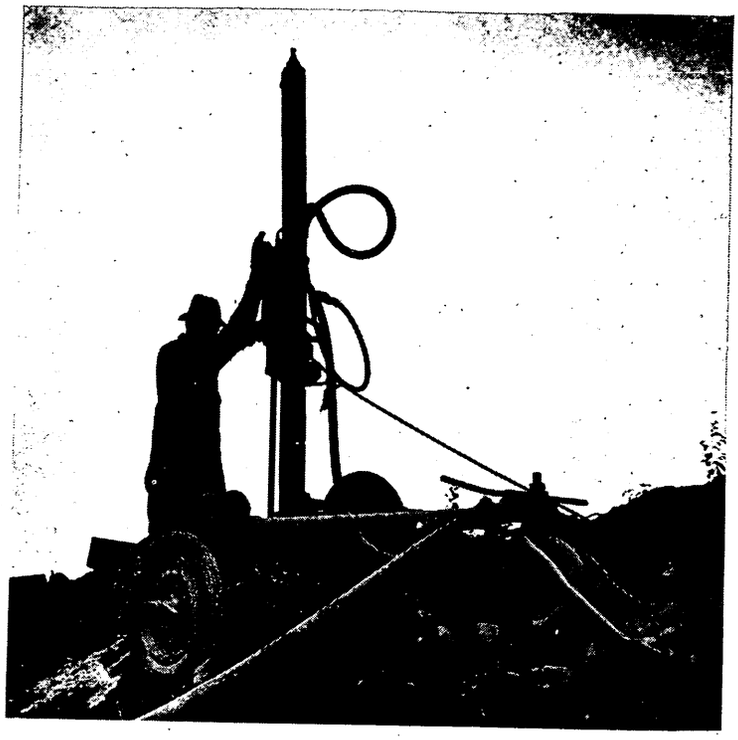
As is shown in the accompanying perspective drawing, the crushing plant is comparatively near the mine, the average haul being about one mile, though from the extreme limits of the pit the distance will be nearer two miles, however, for some time at least, all hauling will be on a level or downgrade, the crushing plant being built in an excavated area, where an opening 89 ft. deep was cut in rock to accommodate the crushers and conveyor.

Primary crushing will be through a gyratory, the capacity of which should be in the neighborhood of 1000 tons per hour, feed coming directly from the trucks as dumped. From this point the product will go through a secondary gyratory, and then to the fine-crushing plant. From the fine-crushing plant the crude ore will be taken by conveyors to three large storage bins, thence to the concentrating plant, which is equipped with rod and ball mills and magnetic separators. The concentrates will go by conveyor to the sintering plant, which is equipped with two continuous sintering machines. As in the other Adirondack sintering plants, anthracite fines will be used for fuel, it being cheaper and more satisfactory than bituminous coal for the purpose.

Supplementary buildings include machine shop, power substation, change house, laboratory, pump station at a small river which crosses the property; a garage for repairing the mine trucks, and a drill-sharpening building.

An adequate supply of labor has necessarily been a problem, the neighborhood being sparsely settled, with no large towns near, and no experienced men available. The construction force had largely to be trained on the job. A staff of some 250 men will be needed for regular operation. Naturally, housing has also been inadequate, the adjoining village of Star Lake being only a small summer resort. Its commercial hotel, the Lakeview, has rarely had any rooms for transients since construction started, and empty houses have been extremely scarce. Many drive many miles to work. A housing development under Government auspices has been under way on the south side of the road between the mine and Star Lake during the last year, which has helped to solve the problem.

One cannot visit this plant, and its near neighbor, Clifton Mines, without coming away with the impression that both are at last permanent camps and are likely to join Lyon Mountain, Mineville, and Tahawus in providing a large tonnage of high-grade iron ore for many years to come. Certainly the reserves appear adequate: the test will be the competition with imported ores and with Lake Superior ores, the supply of which cannot long be maintained without mining lower-grade material.



One of the wagon-drill setups

Type of motor truck used at Benson Mines

NEW YORK CENTRAL SYSTEM

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Report of Investigation No. 2 May, 1949

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MAGNETIC ANOMALIES OF THE RUSSELL, N. Y., QUADRANGLE

(Preliminary Report)

by

Benjamin M. Shaub
Temporary Geologist

NEW YORK STATE SCIENCE SERVICE
THE UNIVERSITY OF THE STATE OF NEW YORK
Albany 1

PRELIMINARY REPORT ON THE MAGNETIC ANOMALIES IN THE RUSSELL, N. Y., QUADRANGLE

INTRODUCTION

The magnetic anomalies of the Russell Quadrangle were selected for investigation by the N. Y. State Science Service during the summer of 1948 because of the unusual results obtained from the aeromagnetic survey in 1945 by the U. S. Geological Survey, and the possibility of not only obtaining interesting and useful technical data but also locating indications of possible economic deposits of iron and/or titanium. The length of the largest anomaly was shown by the aeromagnetic survey to extend in a north-south direction for approximately nine miles (Figure 1). The aerial data also showed this anomaly to be polarized with the negative end to the north and stronger magnetically than the southern positive end.

A five man field party was located on an abandoned school yard at Silver Hill near the middle of the anomaly on July 16, 1948. The dip-needle survey was completed on September 2, 1948.

RUSSELL MAGNETIC ANOMALY

The principal anomaly of the quadrangle, named the "Russell Magnetic Anomaly" (Plates 1, 2 & 3) has a length of 9.9 miles along the base lines and an effective areal extent of 9.1 square miles. The configuration of the isoanomalic contours is much too complex for a simple description. The plan of the survey must be examined together with the topographic contours in order to eval-

uate its significance. The principal part of the anomaly has a strike length of about three miles. The south end of this zone is crossed by the highway leading west from Silver Hill School where the anomaly is the most intense and from 1000 to 1800 feet across. From the wider part the northward extension divides into two well marked branches 1800 to 2000 feet apart. The eastern branch is much the stronger and both fade out toward the north in the vicinity of Hughesville School. To the south the anomaly continues with much less intensity along magnetic zones more-or-less parallel or arranged somewhat in rough echelon fashion. These appear to have no immediate significance or interest.

The rocks along the anomaly conform in strike to the isoanomalic contours and the foliation usually dips rather steeply to the west. The country rock consists chiefly of granitic gneisses with varying amounts of ferromagnesian minerals which appear to be somewhat more abundant in the southern part of the area. In the northern part of the area masses of milky quartz 20 to 50 feet across appear as white areas in the pasture fields. At places the gneisses contain an abundance of sillimanite nodules which are in the planes of foliation. These nodules weather out in relief and are often released from the enclosing rock where the disintegration has been deep enough to free them. They are 1/2 inch to an inch thick and 3 to 4 inches in their longest dimension. Frequently grains of iron ore and ferromagnesian minerals are inclosed in the knots.

Occasional pegmatitic streaks or patches are encountered in the sillimanite and associated gneisses. In these there are

frequently veinlet-like masses or patches of several square inches in extent of iron ores. These ores which were often tested with a Nico magnet always proved to be non-magnetic or only very slightly so. The analysis of a sample of one of the larger occurrences of this nature from an outcrop between lines 8+00 and 16+00, and 600 feet west of the base line extending north from the road running west from near Silver Hill School, gave a Ti/Fe ratio of 0.1133 (10.2% of the two elements is titanium).

An analysis from the Loop prospect located 2000 feet west of the same base line along traverse line 24+00 gave a Ti/Fe ratio of 0.134 (11.82% of the two elements is titanium).

The Loop prospect is in granite gneiss and the ore is intimately associated with apatite which is weakly fluorescent in an orange color.

In contrast with the two previous analyses the iron ore from the Wier prospect between traverse lines 64+00 and 72+00 and 1200 feet east from the same base line has a Ti/Fe ratio of 0.0123 (1.2% of the metals is titanium). The ore from the Wier prospect is rich in places. It occurs in streaks in a feldspathic rock distinctly different from the surrounding granitic gneisses but dipping to the west along the foliation of the gneisses. Another prospect is located about one-half mile northwest from the Hughesville School. The Ti/Fe ratio of the material from this prospect is 0.0054 (the titanium is ½ of one percent of the two elements, a low value). The ore from this prospect is associated with garnet and a suite of ferromagnesian minerals similar

to those at Clifton Mines in the southeastern part of the quadrangle.

The cause of the Russell Magnetic anomaly and its polarization is of course unknown except that magnetic anomalies in general are the result of a concentration of magnetite.

Except for the three iron ore prospects briefly described above, the writer did not see or hear of additional ones within the area surveyed, although it is quite possible that others exist. Of the three prospects mentioned above together with the material taken from a pegmatitic concentration in the granitic gneisses, already described, two are titaniferous and the other two are low in titanium. None of them seems to have any direct connection with the large Russell magnetic anomaly. About 2500 feet to the west, lies the Clark anomaly. The cause of this anomaly is almost certainly believed to be a segregation of iron ores in the gabbro along its contact with the granitic gneisses. The ore taken from this gabbro to the north of the Clark Anomaly along the Russell-Edwards highway has a Ti/Fe ratio of 0.1127 which is close to that of the Loop prospect and the ore from the pegmatitic stringers in the sillimanite granitic gneisses.

From the above data there appear to be at least three possible causes for the concentration of the iron ore which produces the magnetic effects of the Russell magnetic anomaly. They are as follows:

1. Intrusion at depthof iron-rich segregation phases of the gabbro which outcrops to the west;
2. Iron-rich Grenville rocks folded in at depth with

the granitic sillimanite gneisses, or the gneisses thrust over iron-rich rocks of unknown nature.

3. Magmatic segregations and/or intrusions at depth from granitic rocks.

Of these possibilities the writer would somewhat favor them in the order given although data is lacking to support any strong convictions. In the event the first assumption applies the ore would be expected to be titaniferous to the extent of around 10% titanium to 90% iron or higher.

Due to the possibility of deep burial if the ores are rich, or of low grade if near the surface, prospecting in the area would have to be looked upon as a hazardous adventure for risk capital. However, the area is large and it offers intriguing possibilities for the discovery of large iron ore deposits which will probably be titaniferous although the presence of non-titaniferous ores is not to be ruled out.

The most important part of the anomaly is easily accessible from a dirt road which crosses the anomaly. Water is also available from a permanent brook which crosses the highway and anomaly.

Area Within Isoanomalic Contours (based on degree of dip-needle inclination)

Above 20°	contours	- - - - - - - 5.5	acres
10° to 20°	"	- - - - - - - 190	"
0° to 10°	"	- - - - - - 1940	"
-10° to 0°	"	- - - - - - -3170	"
-20° to -10°	"	- - - - - - - 520	"
Below -20°	"	- - - - - - - 72.7	"

SWEET POND MAGNETIC ANOMALY

The Sweet Pond Magnetic Anomaly (Plate 5) consists of two sharply defined linear zones: the northern one strikes N14°W and is 9700 feet in length; the southern zone strikes N43°W and is 7000 feet in length. The former is extremely narrow with a length of 4500 feet within the 10° contour, while the latter is slightly broader and is 6000 feet in length within the 10° contour. The country rock consists of granitic gneisses with varying amounts of ferromagnesian minerals.

Neither the northern or the southern sections appear to have any economic importance at present.

Area Within Isoanomalic Contours (based on degree of dip-needle inclination)

10° to 20° contours - - - - - -	38 acres
20° to 40° contours - - - - - -	12.6 "
Above 40° contour - - - - - -	small patches

The northern part of the anomaly was drilled a few years ago by the Clifton Mines. The option was later dropped.

LAMPSON FALLS MAGNETIC ANOMALY

This anomaly (Plate 7) is located in the central and east ninths of the quadrangle and consists of a broad magnetic plateau of low intensity. The strike of the anomaly varies little from north and south. Except for two small patches the magnetic intensity of the anomaly is less than 20° dip.

The country rock is a garnet-mica gneiss.

While the limits of the ten degree isoanomalic contour extend both north and south beyond the limits of the area surveyed, there do not appear to be any economic aspects to this anomaly. The anomaly lies ½ mile from an old road.

Area Within Isoanomalic Contours

10° to 20° contours - - - 79.8 acres

Above 20° contour - - - 2 small patches

DODGE POND MAGNETIC ANOMALY

This anomaly (Plate 6) consists of two small areas of low magnetic intensity which, except for a couple of small patches, has low angle dips which seldom reach 20°. At one polarized spot the dip exceeds 90° with a null of -12°.

The country rock consists of granitic gneisses with more-or-less granite or granite-like rock and narrow bands of amphibolite along the foliation which strikes in a general north and south direction. Neither of the two small areas appears to have any economic importance.

Area Within Isoanomalic Contours (based on degree of dip-needle inclination)

10° to 20° contours - - - - 5.1 acres

Above 20° contour - - - - 2 small patches

CLARK MAGNETIC ANOMALY

The first indication of this anomaly (Plate 4) was obtained by Wallace Clark who supervised the magnetic work of the Russell Quadrangle in the field. It was located by chance dip-needle

observation while Clark was collecting minerals in a part of the quadrangle not known to be strongly magnetic. A dip reading near the contact of the gabbro and granite gneisses gave a dip of 20°. As the anomaly lies chiefly in pastures and is crossed by a macadam highway, the work was "fit into the weather" with considerable advantage.

The anomaly lies within the anorthositic-gabbro which is of the order of a mile wide and extends for about four miles in a north-south direction and is situated principally on the boundary between the central and west central ninths of the quadrangle. As the anomaly lies within the gabbro, along the contact between the gabbro and the granitic gneisses, it quite probably represents a magmatic segregation of iron ores in the gabbro.

A sample of non-magnetic iron ore collected from a small basic pegmatite in amphibolite along the road near the contact gave a Ti/Fe ratio of 0.534 (34.75% of the two elements is titanium).

The northern end of the gabbro intrusion is crossed by the highway from Russell to Edwards. Recent blasting in the gabbro exposed fresh material from which pieces of the fresh rock were collected, some of which were relatively rich in interstitial iron ores. A sample was obtained by crushing the rock and separating the ores from non-metallic minerals by the use of a Nico magnet. This may not have picked up ilmenite that was released from the magnetite during crushing. The Ti/Fe ratio of this iron concentrate is 0.1133 (10.2% of the two elements is titanium). The magnetic profile along the highway, where the sample was obtained, is weak and close to the zero level.

The contact rock at the north end and on the east side is a feldspathic phase of the Grenville series which contains considerable pyroxene and amphibole although it is of a light gray color. The Grenville contact rock has been extensively altered along a zone up to 30 feet in width by the aqueous constituents from the magma.

The pronounced hydrothermal reactions at the contact, the interstitial character of the ores, and the result of the analyses suggest the possibility that there may be commercial lenses or deposits of titaniferous iron ores along the contacts within the gabbro. The ore from this occurrence would be expected to yield a concentrate having a titanium-iron ratio of 0.10 or somewhat above this value. The area of the anomaly will be easy to prospect by drilling as the numerous rock outcrops suggest a shallow mantle of till. The area is in open pasture fields and a permanent brook about ¼ mile distant would supply adequate water.

The limits of the anomaly were not covered in the survey as the ten and probably the twenty degree contours are open on the south. The entire contact area about eight to ten miles in length appears to be more-or-less favorable ground for prospecting for titaniferous ores.

Areas Within Isoanomalic Contours (based on degree of dip-needle inclination)

10° to 20° contours - - - - 18 acres

Above 20° contour - - - - 1.70

STATISTICS RELATING TO MAGNETIC SURVEYS IN

THE RUSSELL, N. Y. QUADRANGLE

Summer of 1948

Name of Anomaly	Distance Traversed in Miles	Area Covered in Survey	Total Dip Readings Taken	Readings per Acre
Russell Magnetic Anomaly	59.8	5800	3309	0.57
Lampson Falls Magnetic Anomaly	4.8	291	268	1.09
Clark Magnetic Anomaly	4.7	148	392	2.63
Dodge Pond Magnetic Anomaly	5.2	193	310	1.6
Sweet Pond Magnetic Anomaly	7.6	462	440	0.95
Total	82.1	6894	4719	

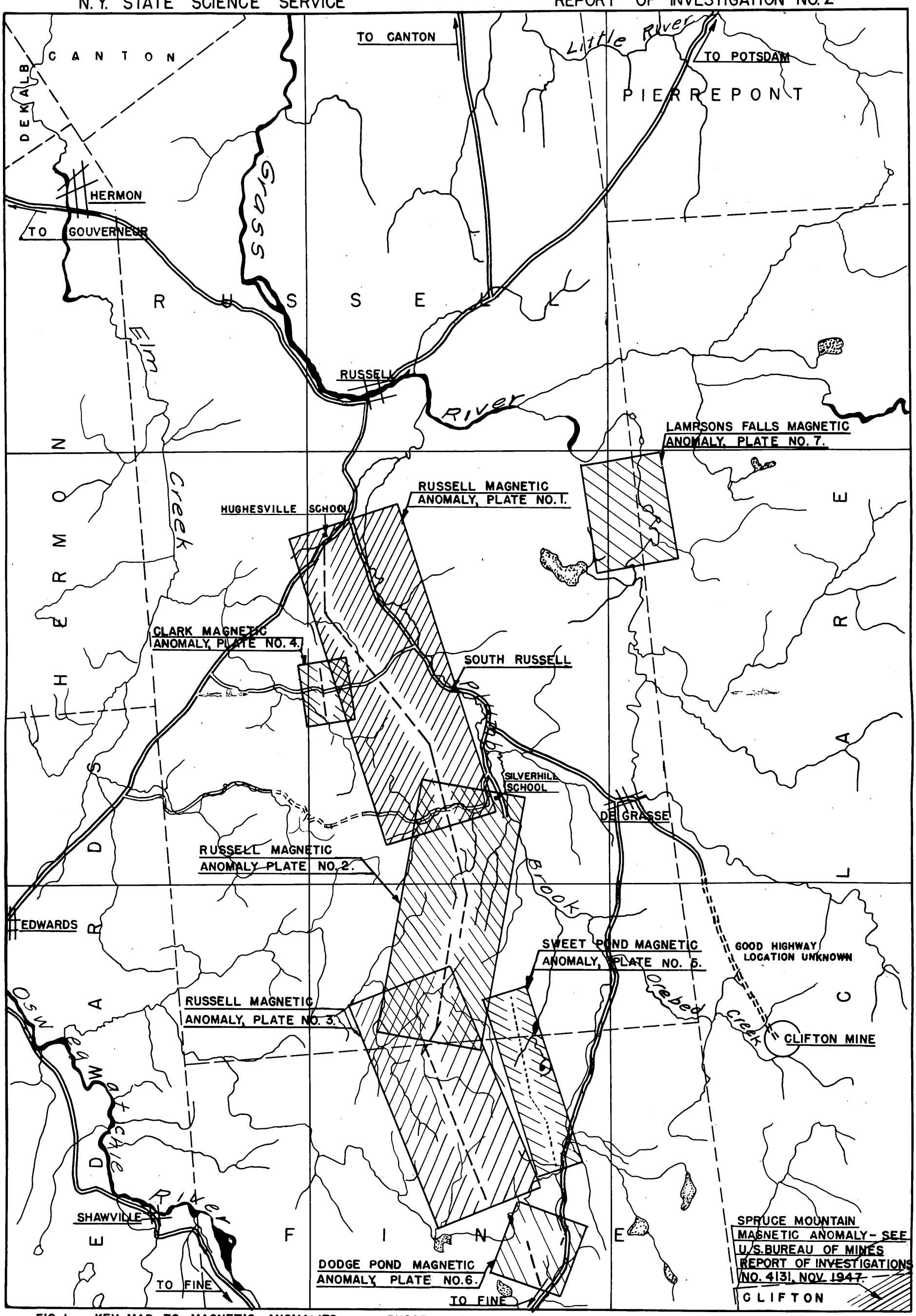
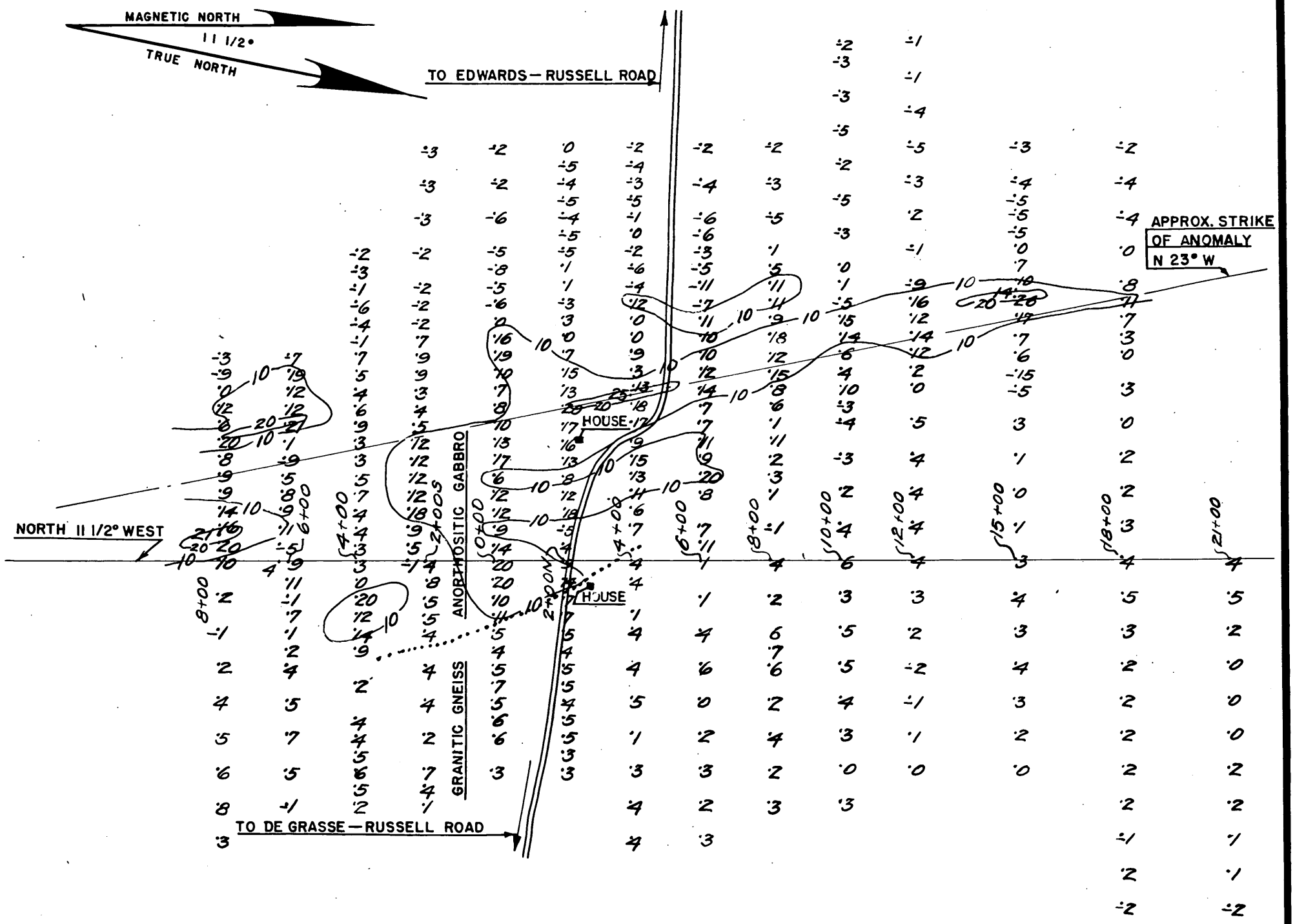


FIG. 1— KEY MAP TO MAGNETIC ANOMALIES, RUSSELL, N. Y. QUADRANGLE.

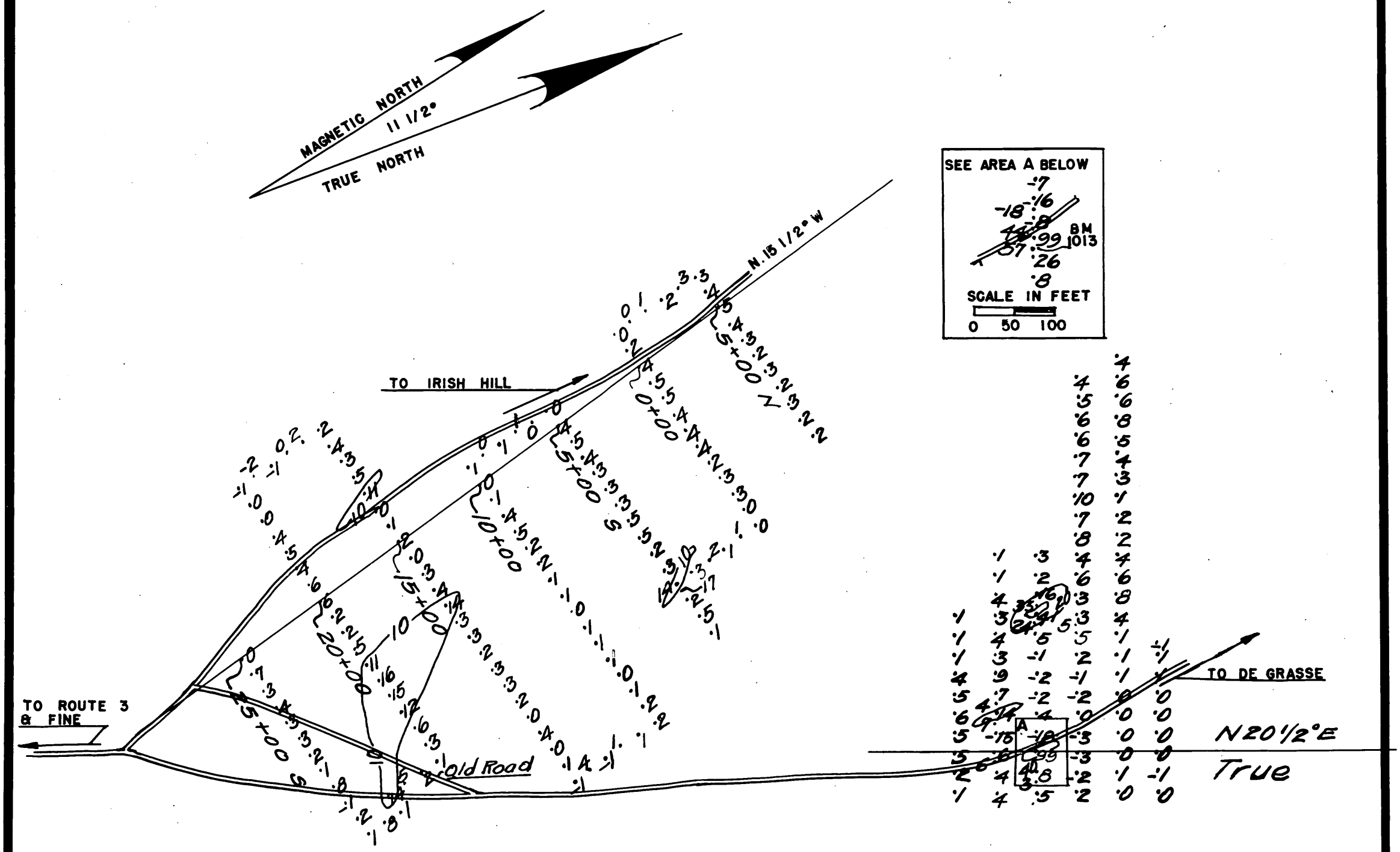
SUMMARY OF DATA OBTAINED ON MAGNETIC
ANOMALIES IN THE RUSSELL, N. Y. QUADRANGLE
Summer of 1948

Anomaly	Distance from Accessible road	Country Rock	Shape of Anomaly	Strike Length Within Isoclinal Contours in ft.	Area Within Isoclinal Contours in Acres	Ti/Fe	Potentialities
Russell	Crossed by two highways	Granitic gneisses	Linear	Extensive and intricate see plan of isoclinal contours, Plates 1, 2,3	20° to 40° - 5.5 10° to 20° - 190 -10° to 20° - 520 -20° to-40° -72.7	See Description of Anomaly	Fair - needs further prospecting by drilling
Dodge Pond	Crossed by two highways	Granitic gneiss with amphibolitic and granite facies	Irregular	Irregular	10° to 20° - 5.1	___	Poor
Clark	Crossed by highway	Anorthositic gabbro	Irregular linear	Irregular	10° to 20° - 18 About 20° - 1.7	0.1133	Fair for titaniferous ores
Lampson Falls	½ mile t o old road	Garnet-mica-gneisses	Broad irregular	Irregular	10° to 20° - 79.8	___	Poor
Sweet Pond	South end crossed by highway. North end one mile from highway	Granitic gneisses	Sharply linear	10° to 20° 11,000 ft. 20° to 40° 5.000 ft. 40° to 60° 600 ft.	10° to 20° -38 20° to 40° - 12.6 40° to 60° small patches	___	Poor



CLARK MAGNETIC ANOMALY
RUSSELL, N.Y. QUADRANGLE
CENTRAL AND WEST CENTRAL NINTH
PACE & COMPASS SURVEY 1948
SURVEY MADE BY B. M. SHAUB & ASSISTANTS

SCALE IN FEET
250 0 250 500



DODGE POND MAGNETIC ANOMALY
RUSSELL, N.Y. QUADRANGLE
SOUTH CENTRAL NINTH
PACE & COMPASS SURVEY 1948
SURVEY MADE BY B. M. SHAUB & ASSISTANTS

SCALE IN FEET
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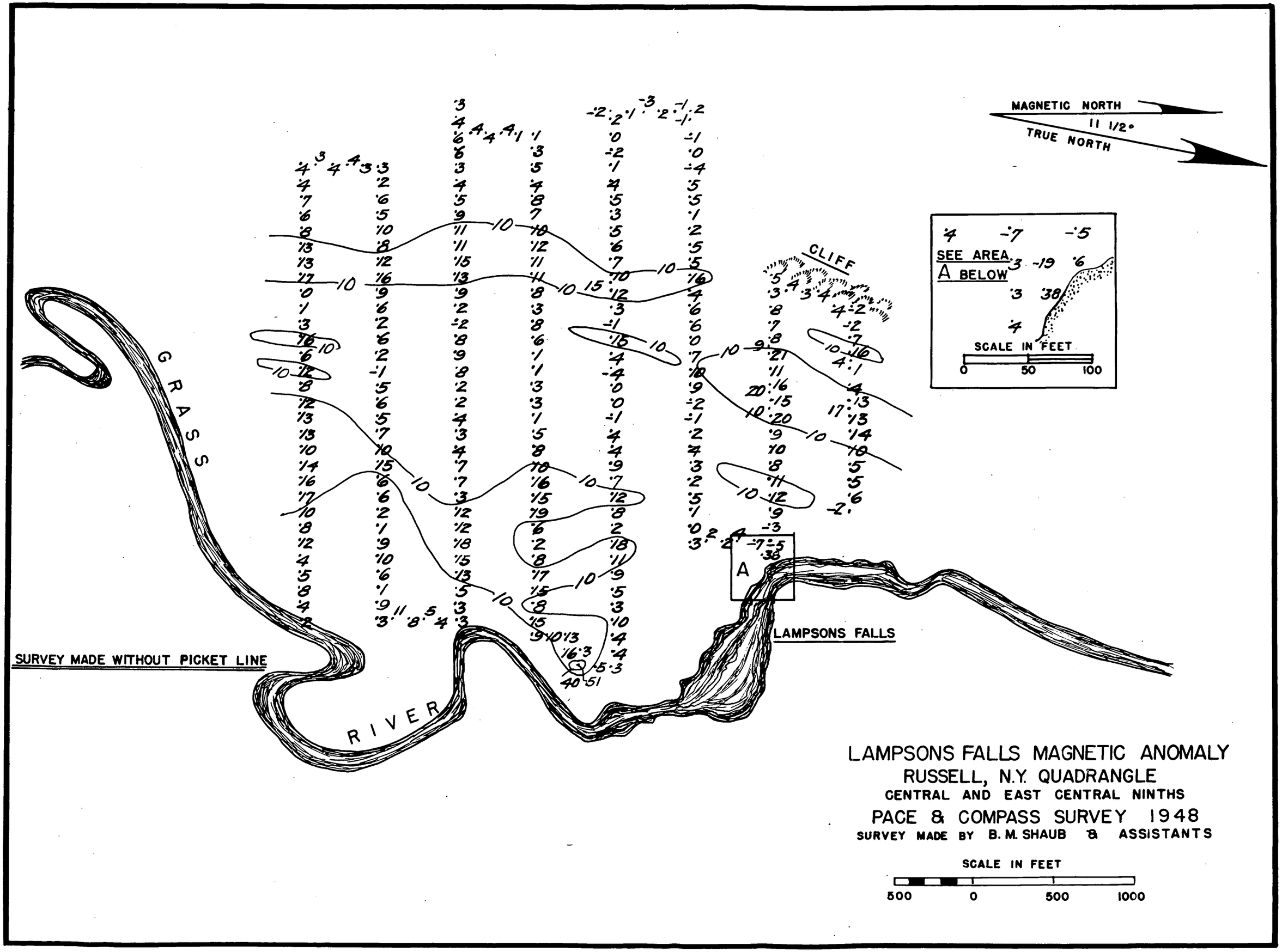

LAMPSONS FALLS MAGNETIC ANOMALY
RUSSELL, N.Y. QUADRANGLE
CENTRAL AND EAST CENTRAL NINTHS
PACE & COMPASS SURVEY 1948
SURVEY MADE BY B. M. SHAUB & ASSISTANTS

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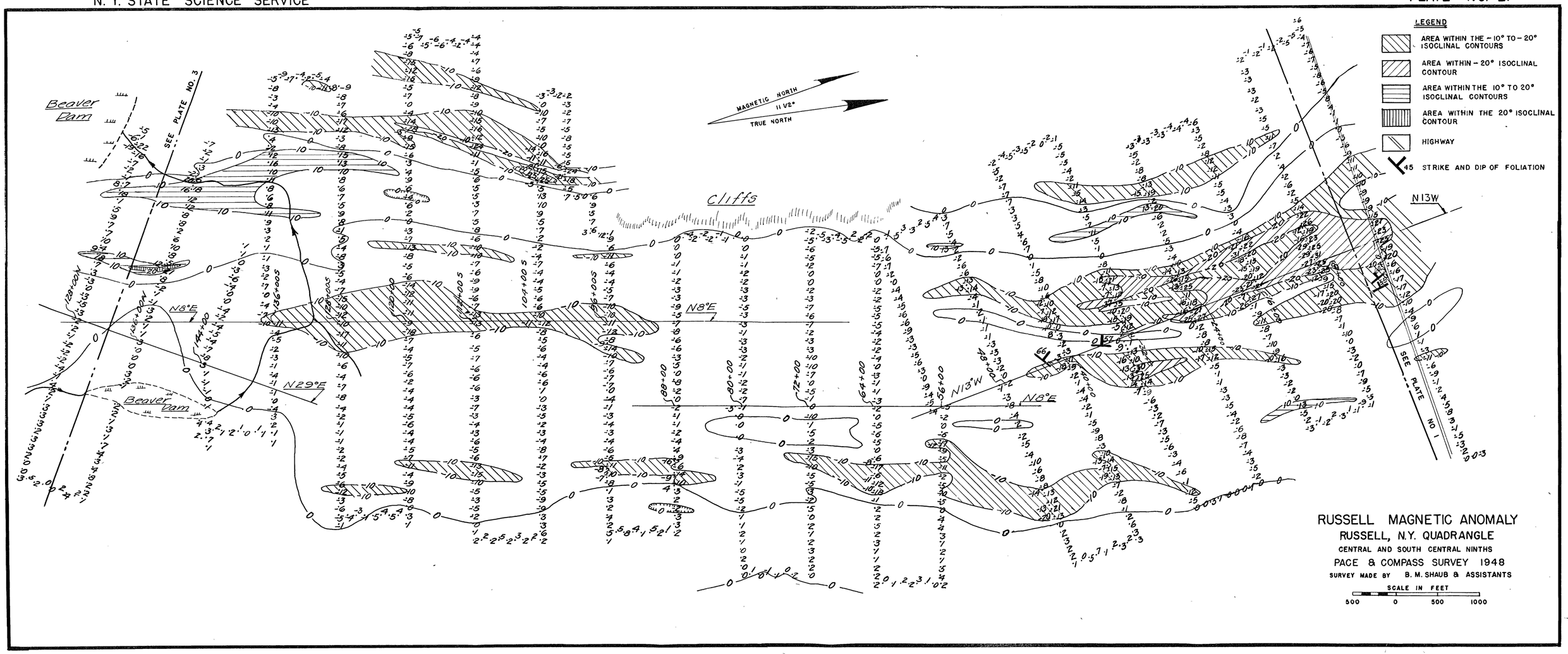
LEGEND
AREA WITHIN THE -10° TO -20° ISOCLINAL CONTOURS
AREA WITHIN -20° ISOCLINAL CONTOUR
AREA WITHIN THE 10° TO 20° ISOCLINAL CONTOURS
AREA WITHIN THE 20° ISOCLINAL CONTOUR
HIGHWAY
45 STRIKE AND DIP OF FOLIATION
MAGNETIC NORTH
11 1/2°
TRUE NORTH
Beaver Dam
SEE PLATE NO. 3
Cliffs
N8°E
N29°E
N13W
SEE PLATE NO. 1
RUSSELL MAGNETIC ANOMALY
RUSSELL, N.Y. QUADRANGLE
CENTRAL AND SOUTH CENTRAL NINTHS
PACE & COMPASS SURVEY 1948
SURVEY MADE BY B. M. SHAUB & ASSISTANTS
SCALE IN FEET
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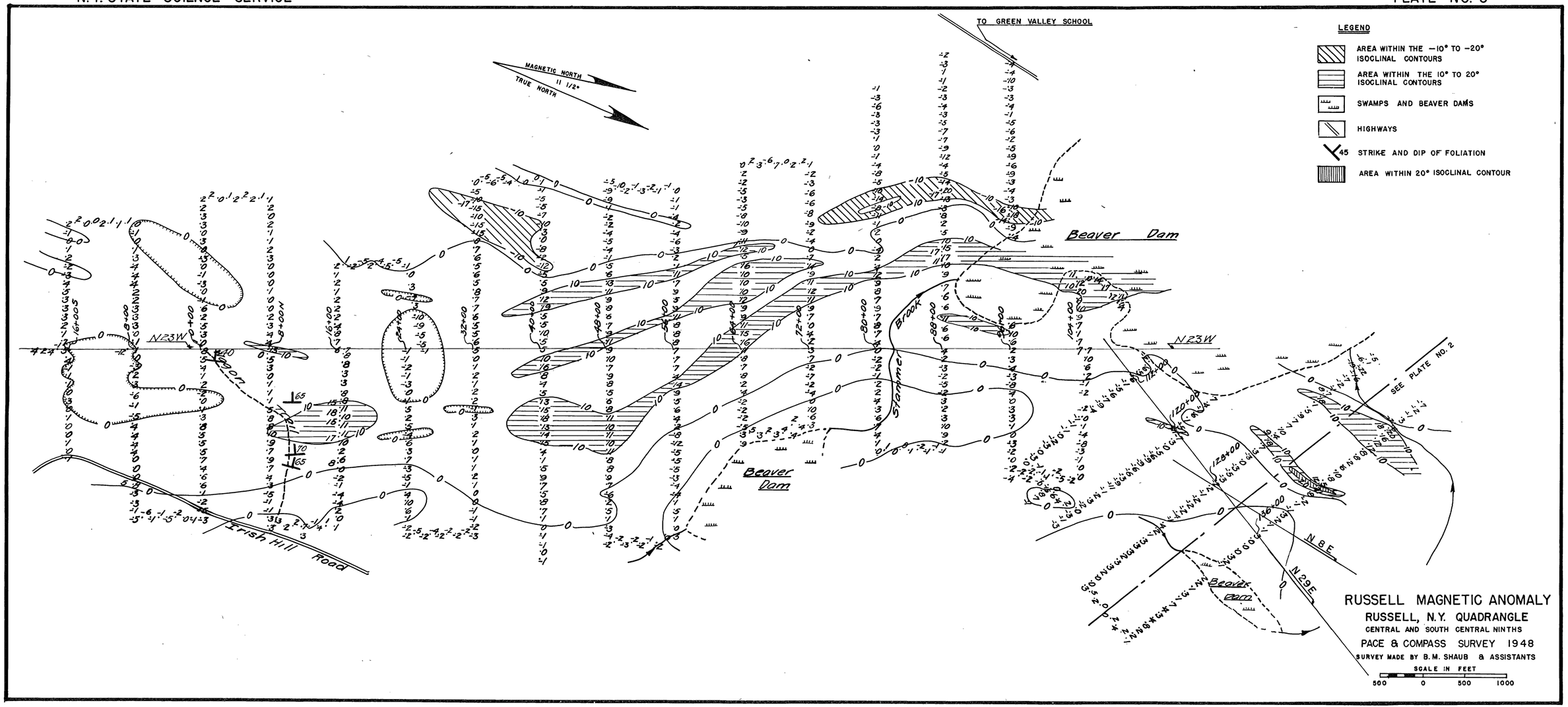
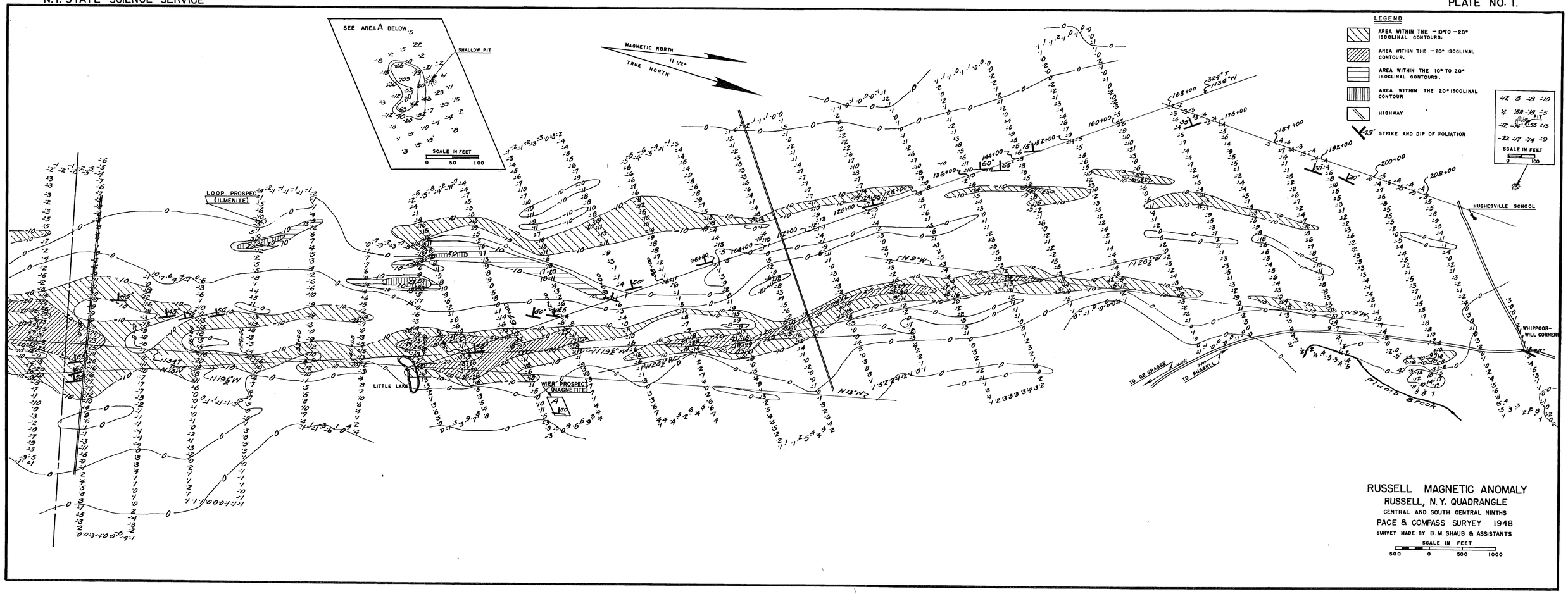

TO GREEN VALLEY SCHOOL
MAGNETIC NORTH
11 1/2°
TRUE NORTH
LEGEND
AREA WITHIN THE −10° TO −20° ISOCLINAL CONTOURS
AREA WITHIN THE 10° TO 20° ISOCLINAL CONTOURS
SWAMPS AND BEAVER DAMS
HIGHWAYS
45 STRIKE AND DIP OF FOLIATION
AREA WITHIN 20° ISOCLINAL CONTOUR
Beaver Dam
Stammer Brook
N23W
N23W
N29E
N8E
Beaver Dam
Beaver Dam
Irish Hill Road
SEE PLATE NO. 2
RUSSELL MAGNETIC ANOMALY
RUSSELL, N.Y. QUADRANGLE
CENTRAL AND SOUTH CENTRAL NINTHS
PACE & COMPASS SURVEY 1948
SURVEY MADE BY B.M. SHAUB & ASSISTANTS
SCALE IN FEET
500 0 500 1000

UNIVERSITY OF THE STATE OF NEW YORK
N.Y. STATE SCIENCE SERVICE

REPORT OF INVESTIGATION NO.
PLATE NO. I.



RUSSELL MAGNETIC ANOMALY
RUSSELL, N.Y. QUADRANGLE
CENTRAL AND SOUTH CENTRAL NINTHS
PACE & COMPASS SURVEY 1948
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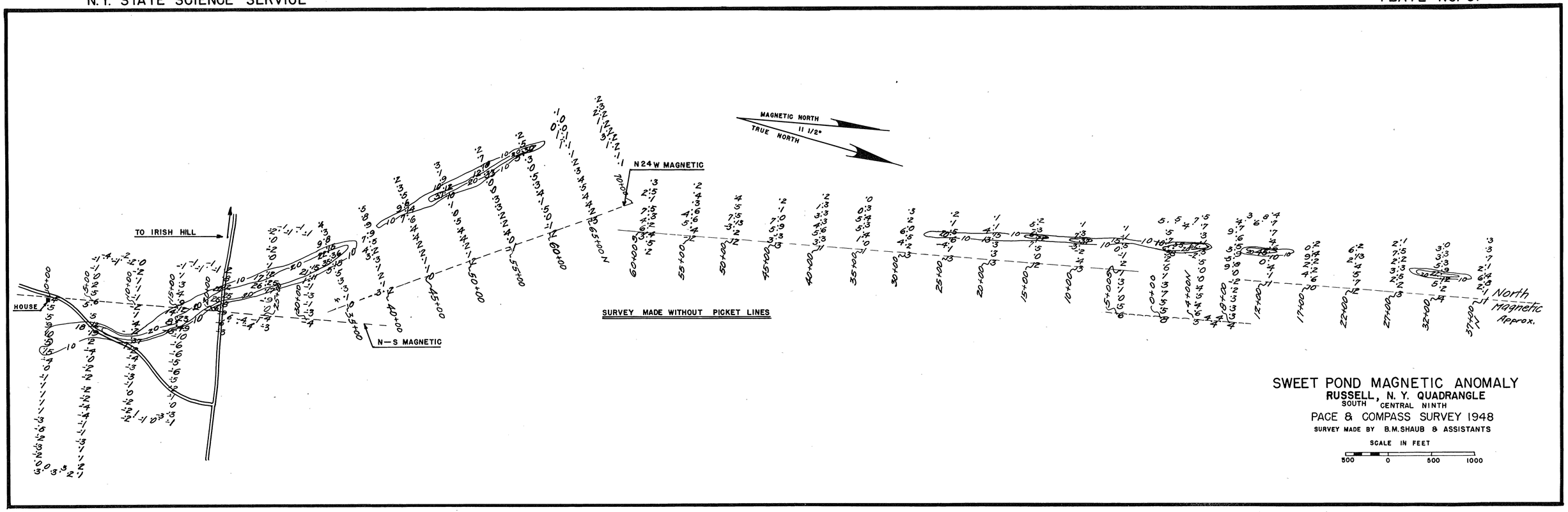
MAGNETIC NORTH
11 1/2°
TRUE NORTH
N 24 W MAGNETIC
TO IRISH HILL
HOUSE
N—S MAGNETIC
SURVEY MADE WITHOUT PICKET LINES
North
Magnetic
Approx.
SWEET POND MAGNETIC ANOMALY
RUSSELL, N. Y. QUADRANGLE
SOUTH CENTRAL NINTH
PACE & COMPASS SURVEY 1948
SURVEY MADE BY B.M.SHAUB & ASSISTANTS
SCALE IN FEET
500 0 500 1000