REPORT
of the
STATE GEOLOGIST
1942-43
ORONO, MAINE, MARCH 1, 1943
"The development of the natural resources of the State and of the Nation, and likewise their conservation, is dependent upon a knowledge of what these resources are, how they can best be recovered, and for what they can be used. The more abundant these resources are, the greater is man's opportunity for better living conditions and the greater also is the opportunity for employment in diverse occupations. The more perfect and thorough this knowledge, the greater will be the development of a region and the sounder will be the basis for wise and practicable measures for conservation. This is the field for natural resource surveys. Their place is fundamental. They are essential to a high civilization." 

REPORT OF
JOSEPH M. TREFETHEN, State Geologist

SERVICES AND PROGRAM OF THE SURVEY

Service

One of the primary functions of the State Geologist is to render service to the people of the State by answering questions relating to geological and mineralogical subjects. This is done free of charge insofar as information is available. Specimens are identified without charge, and in instances of some types of materials, assays, or analyses are run. Specimens for identification should be mailed with locality and sender's address inclosed to the office of the State Geologist, Orono, Maine.

Visits to mineral localities and advice as to their merits are made, so far as possible, within the limits of time and funds available. In this connection it should be stated that at present the chief efforts are towards investigation of mineral deposits of strategic or war time significance. By advice directing exploratory development, and by advice against useless excavation or development much fruitless expenditure can be avoided. The multitude of holes sunk at expense of labor and time and money in places where there is no indication of profitable returns testify to the real need and value of this service.

Exploration and Geological Mapping

Certain areas in the State, because of economic prospects, warrant more or less detailed exploration and geological mapping. It is planned to carry on this type of work, results of which will be made available to the public. The location of materials for public construction should result in real economies. Information on specific localities and prospects is cleared through the Maine Development Commission, prior to publication. Assistance in prob-
lems of development and technical advice connected with developments should be secured through the Development Commission.

Investigation of mineral deposits is a continuing function because of technological developments. Many minerals in demand today were non-economic a few years ago, and equally rapid developments can be anticipated in the future. Scientific and educational work not related directly to the exigencies of war time are deferred. The widespread interest in geological and mineralogical matters encountered throughout the State during the past field season, and shown also by the number of inquiries received by mail, is encouraging.

The geological work sponsored by the State of Maine is being carried on in cooperation with the federal agencies, the U. S. Geological Survey, the Bureau of Mines, and Colonial Mica Corporation.

LEGISLATION RECOMMENDED

Legislation designed to encourage prospecting by insuring the rights of both prospector and landowner is desirable. In addition, some form of registration of mineral leases and prospects would be beneficial, as would also provisions for filing of drilling records with the State.

CURRENT REVIEW OF MINERAL RESOURCES OF MAINE

To evaluate the possible contribution of Maine mineral deposits to the national war effort, it is necessary to view such potentialities against the background of current trends in the mineral industries, mineral technology, and war-time economy. Therefore, to place our possible mineral contributions in proper perspective, a few generalizations on the mineral industries are in order. These will be followed by an outline of Maine's mineral resources with particular reference to those minerals of special significance in war time.

In viewing the current national mineral situation, the first and most impressive fact we come up against is the tremendously increased scale of mineral use and production. For every ton of iron and copper used in 1841 more than one hundred tons were
used in 1941, and in 1943 probably the 1941 consumption will be increased by at least fifty per cent. Even in peace times sixty to seventy per cent of the rail tonnage and some twenty-five per cent of the water borne freight consisted of mineral material. Out of these tremendously increased requirements, evidenced by shortages in even the mineral substances with which we are most abundantly supplied, have come unprecedented demands for production converging on the relatively few dominant sources of supply capable of yielding huge tonnages. To supplement the tonnage of the great producing areas, every effort is being made to bring in auxiliary production from new areas, and to reactivate production from certain areas formerly worked, but which, because of economic reasons, had become unprofitable in a peace-time economy.

This tremendous increase in demand accentuates trends already evidenced in the mineral industry previous to the war, namely utilization of scrap, and of lower grade ores. One of the outstanding achievements of metallurgical technology has been the development of methods for cheap and efficient recovery of the metals from low grade ores, and this field of research holds great future promise.

The first world war brought us to realize that the United States is not self-sufficient in terms of minerals. Our allies are even more dependent than we are upon distant mineral sources of supply. The burden of shipping tonnage required to move our own troops, supplies and equipment, as well as supplies and munitions to associated nations, is tremendous. Precarious and distant shipping routes to normal sources of mineral supply together with the increased requirements of the same make it imperative to develop our internal supplies to the utmost.

The realization of mineral shortages has led to the compilation of lists of mineral materials dangerously scarce, which are basic to our industries. There are several degrees of shortage. The most urgently pressing shortages are those on the strategic list of the War Department—"those mineral materials essential to national defense for the supply of which in war dependence must be placed in whole or in large part on sources outside the continental limits of the United States, and for which strict conservation and distribution control measures will be necessary." ¹

This list of strategic minerals includes those supplying:

- Aluminum
- Antimony
- Chromium
- Manganese
- Mercury
- Mica (sheet)
- Nickel
- Tin
- Tungsten

In summary of the foregoing several points stand out:

1. New sources of supply are being sought to supplement production and old deposits being re-examined in light of present needs.
2. Technology is rendering usable deposits of grades not formerly commercial.
3. There are some minerals that in time of war assume special importance.

The strategic list given above is taken up alphabetically with a few comments in the following paragraphs, and Maine's possible contributions summarized.

**Aluminum.** At present the only commercial ore is bauxite, a hydrous aluminum oxide. No deposits of bauxite have been reliably reported in Maine, and none are anticipated. Aluminum is an important constituent of some types of clay. Maine clays, however, are chiefly glacial, rock flour clays, not of a high alumina type.

**Antimony.** The chief ore of antimony is the easily recognizable metallic looking sulfide. Only traces have ever been reported in this State. Chances for discovery of a commercial deposit are considered remote.

**Chromium.** Chromite, the chief ore of chromium, occurs associated with basic rocks of the type found on Deer Isle and in Jim Pond Township. While it may occur in some quantity, major deposits are doubtful.

**Manganese.** Every ton of steel manufactured requires about fourteen pounds of manganese. Explorations of large tonnage, low grade deposits in Aroostook County are now in progress. Utiliza-
tion is contingent on development of a technique in handling the low grade, somewhat refractory, ores. If this can be accomplished in the near future, Maine will make a very significant contribution. The occurrence of the manganese and progress of exploration is more fully treated in another section of this report.

Mercury. There are no indications that mercury will ever be produced in this State.

Mica. Strategic or splitting mica occurs in only limited quantity, so far as investigations to date have shown. A discussion of the mica situation is given in another section of this report.

Nickel. The chief nickel deposits of the world are in Ontario. That region produces some ninety-five per cent of the world production. An apparently small deposit of very low grade nickel ore is present in the town of Warren. Some further exploration is justified.

Tin. Cassiterite is found at several places in the State. However, the geological occurrences of the material where found do not warrant much hope of production. The occurrence at Winslow, which has received more or less publicity, does not appear encouraging.

Tungsten. We have been dependent on the far east, particularly China, for our tungsten. Recently, western deposits have been opened that somewhat alleviate the domestic situation. In Maine tungsten minerals occur very sparingly in some of the pegmatites. It is possible that exploration will show tungsten minerals, notably scheelite, to be present in other areas. The search appears warranted.

OUTLOOK FOR MINERALS NOT ON STRATEGIC LIST

Metallics

Beryllium. Because of the remarkable properties imparted by small amounts of beryllium in alloys, there has been increasing demand for production of beryl, virtually the only source of beryllium at the present time. A brief discussion of the beryl situation and of Maine's possible production is given in a later part of this report. (See page 8.) There are good prospects of increased production in Maine.

Columbium and Tantalum. The relatively rare metals, columbium and tantalum, are known to occur sparsely in the pegma-
tites of several localities in the State. The mineral columbite-tantalite, source of both metals, occurs very sparingly. Some thirty pounds or more was taken out of the Newry quarry in the summer of 1942, and the presence of the mineral is noteworthy on Black Mountain at Rumford. From the nature of its occurrence in the pegmatites, columbite-tantalite is a by-product of pegmatite operations for other substances.

**Copper.** The copper shortage due to expanded war needs has taxed the capacity of the large western copper districts to the utmost. New England copper mines, long unworked, are being reviewed with reopening of several under way, and of others pending. The Vermont deposits at Ely are examples of reopened copper mines. The Blue Hill deposits fall into the group meriting consideration, and further developments there depend on the turn of world events. The geology of the area has been mapped; core drilling and dewatering the old workings may be justified.

**Lead and Zinc.** The increased demands for lead and zinc have also led to shortages in both those metals, though to a degree less marked than in the case of copper. Workings for lead have been unsuccessful in the past due to high cost mining and relatively small deposits. Several small veins of from one foot to two feet in thickness, which carry lead in enough quantity to be considered ore, occur in the vicinity of Lubec. If lead shortages become sufficiently acute this region could be reopened. Zinc prospects on Penobscot Bay, Castine quadrangle, have been recently drilled but results of the drilling are not yet available.

Copper, lead, and zinc prospects were examined also in West Pembroke. There are insufficient indications of good grade ore to warrant recommendation of these prospects.

**Molybdenum.** Demand for molybdenum is increasing, both because of increased use for normal molybdenum alloy steels and because it can be used as a partial substitute for such metals as tungsten in ferro alloys. The chief ore mineral is molybdenite, the molybdenum sulfide. Noteworthy molybdenum occurrences in Township 10, Cooper, and Houlton were visited during the field season. Of these, the Cooper deposit appears to offer the most promise. Further field study of these areas is projected. A small

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mill was formerly operated at Cooper. It is possible that production could be brought back under war stimulus.

Non-metallics

Many minerals other than ores of the metals are now in demand. It appears probable that with possible exception of manganese the production of non-metallic minerals will dominate in the future development of Maine mining. New uses and new processes of recovery hold much promise for the non-metallics.

**Andalusite.** Andalusite, kyanite, and sillimanite \((Al_2SiO_5)\) are varieties of the same chemical compound. They are used in the ceramic trades, especially important now in the manufacture of such products as spark plugs. Many occurrences of andalusite and a few of sillimanite are known in the State. Distinction must be made, however, between occurrences and deposits of economic size and purity. Commercial grade andalusite deposits were examined in the vicinity of Byron and Standish. The problem is to locate larger deposits of similar type, if such exist. There is a large body of sillimanite gneiss in Warren that may prove commercial. Laboratory work on the material is in progress. There is distinct hope that commercial deposits of one or more of these minerals will be discovered.

**Asbestos.** Asbestos is reported from time to time in this State. The Jim Pond region has yielded some specimens of non-commercial grade. Roadside outcrops were examined there last summer, and the region merits some further prospecting.

**Feldspar.** Feldspar has been, and is at present, one of the important mineral products of the State. Several large mines were in operation during 1942 in Oxford and Sagadahoc Counties. A number of smaller operations also were in production.

**Granite.** Granite production has declined during this year. One of the best equipped granite works in the State was dismantled and the buildings reassembled in a shipbuilding center. The present outlook for this industry is not encouraging. However, with resumption of peace times, the quality and favorable location of Maine granites with respect to tide water should secure a normal expansion of granite production.

**Gravel and Sand.** In peace time, gravel and sand constitute
one of the chief geological products of the State. With the curtail-
ment of highway construction production has diminished.

**Limestone (Marble).** The only considerable production of
limestone in the State is in the Thomaston district. The product is
used chiefly in cement manufacture. There is every reason to be-
lieve that agricultural lime can be produced in other areas of the
State. One of the projects that will be carried out as soon as feasible
will be a survey of the potential areas of lime production.

**Marl.** Deposits of marl (CaCO₃) in lakes are known at vari-
ous places. Locally they have been worked, as in Limestone,
Aroostook, for land lime. Small quantities of suitable land lime
can be recovered from these sources, and the projected survey of
limestone resources will include these deposits.

**Peat.** Peat production has expanded during the past year.
Prospects for continued development of this resource are favorable.
While the bulk of the output is utilized for agricultural purposes,
new uses for the material will probably create a larger demand.

**Slate.** Quarrying and milling of slate, at present chiefly for
electric switchboard purposes, is centered at Monson. The principal
quarry is an underground working. Maine slate is of good
quality. If a use can be developed for the waste material, the in-
dustry would profit materially. The Monson quarries and mill
were active in 1942.

**Spodumene.** Spodumene, a lithium aluminum silicate, found
in the pegmatites, is in strong demand at the present time. About
ten tons were produced in the State in 1942. A deposit that should
yield some quantity is the Rumford Black Mountain area. Another
deposit, apparently small, that produced at one time is the Starrett
property, Warren. Areas in the vicinity of both these deposits war-
rant prospecting.

**BERYLLIUM**

Beryllium has come to public notice through many newspaper
accounts and magazine articles in recent time. Alloys of copper
with 1% to 2.5% beryllium have remarkable properties. The
tensile strength of the copper is increased from 30,000 or 40,000
pounds per square inch to about 200,000 pounds per square inch.
It can be heat treated to hardness beyond that of the ordinary
bronzes, thus finds use in the manufacture of non-sparking tools.
It is also especially adapted to making smooth castings. The chief and virtually only ore of beryllium at present is beryl, the beryllium aluminum silicate, which contains 12 to 14% BeO when pure. Beryl occurs in the pegmatites sparsely and sporadically disseminated, or in rare cases concentrated in a beryl-rich zone. Not enough data are yet available to establish the preferred distribution, if any, of beryl within the pegmatites although probably structural studies of the pegmatites will eventually lead to conclusions that may be of assistance to the prospector.

Beryl crystals range in size from a fraction of an inch in diameter up to a known maximum of over four feet; in length, from a fraction of an inch up to sixteen feet. Crystals less than a few inches in diameter and less than a foot long are the most common.

The Bumpus Quarry, Albany, Maine, has yielded beryl on a small tonnage basis, chiefly from relatively few large crystals. The largest beryl crystals ever discovered were in this deposit. The quarry has not been in operation for several seasons. Large beryl crystals are showing in the walls and floor of the quarry at the present time.

The only other property which has produced much beryl is the Black Mountain Quarry, Rumford. The beryl here is white and apparently concentrated in irregular zonal fashion. The property was operated in 1942 for scrap mica.

At the present price, and by the present method of hand cobbing the product, it is doubtful if any pegmatite could long be successfully operated for beryl alone. It constitutes a valuable by-product, however, of feldspar and/or mica production.

The Newry, Rumford, Roxbury belt, and adjacent towns merit further prospecting, and other areas also show some promise.

**REVIEW OF MICA POSSIBILITIES IN MAINE**

War-time expansion of the vital electrical industries, the largest consumers of mica, puts certain classes of mica into critical position. The United States has been largely dependent on import of strategic grades of mica; now every effort is being made to reduce dependence on external sources of supply. Maine’s possible contributions to this effort are best evaluated after presenting a summary of the current mica situation.

Mica is the family name for a group of several related minerals. The common light-colored or clear variety, muscovite, is popularly
Characteristics and Occurrence of Mica

known as “isinglass.” The dark brown to black variety is biotite. The outstanding characteristic of mica is its capacity to split into thin flexible sheets that are elastic in the sense that after bending they spring back into shape. Muscovite is a heat proof, water and acid proof electrical insulator and dielectric. These properties render it invaluable in certain uses.

While mica occurs in a finely divided state in many rock types, large “books” or crystals are limited to the pegmatites. The pegmatites are coarsely and irregularly crystallized igneous rocks consisting primarily of feldspar and quartz. They are the chief sources of feldspar. While a great variety of other minerals are found in the pegmatites, also, the chief economic interest centers in feldspar, muscovite, beryl, spodumene, lepidolite, columbite-tantalite, and the semiprecious gems. The irregularity of the pegmatites should be stressed. It is impossible to make predictions much beyond what can be seen exposed, as to their make-up. The irregular and sporadic occurrence of minerals and mineral zones renders core drilling of little value in prospecting pegmatites.

The mica may occur disseminated sporadically through the pegmatitic mass, or it may occur in irregular zones or “veins” in the pegmatite, in which mica is relatively more abundant. The latter occurrence is, of course, more favorable to mining. These richer zones may occur in any part of the pegmatite body. There appears to be a tendency, however, for such zones to follow the margins of the pegmatite body. This is illustrated diagrammatically in figure 1 which shows a cross section of the Hibbs mine, Hebron, as interpreted by the writer.

![Figure 1. Cross-section of Hibbs Mine, Hebron, Me.](image-url)
Figure 2. Ruling in Mica

Figure 3. "Fishbone" structure in mica
Figure 4. Wedge structure in mica

Figure 5. Staining in mica. Appears to follow both percussion and pressure figures
The zones themselves may die out, change character, becoming either better or poorer as they are worked, or may maintain their identity and character for considerable distances. This irregularity is characteristic both of horizontal and vertical extensions.

In order to yield much mica of sheet or strategic grade many of the crystals must average, at least, several inches in diameter.

**Classification**

*Imperfections.* Mica not suitable for splitting dominates in the Maine pegmatites. Imperfections known as ruling are abundant. Ruling consists of sharp flexures or bends in the plates, or in actual straight parting planes not in the cleavage plane of the mineral. These may be so closely spaced as to render useless the material for other purposes than scrap. Ruling is shown in figure 2. Another common flaw in mica is fish-bone structure as shown in figure 3. Such structure renders the crystal unsuitable for anything but scrap. Wedge structure, as shown in figure 4, is a common defect. Still another imperfection, that not uncommonly impairs the usefulness of sheet mica since it affects the insulating and dielectric properties, is the presence of foreign mineral material, commonly present as staining or mineral inclusions between the sheets. Iron oxides are apparently the chief impurities of such nature. Figure 5 illustrates stained mica. One other imperfection may be mentioned. The mica books may be "warped" or have undulating surfaces to the extent that they do not qualify for some uses.

**Qualities**

*I—Scrap.* Scrap mica includes not only that disqualified because of such imperfections as outlined above, but also waste from cutting and trimming, and crystals too small to yield good clear areas large enough to punch into small shapes (as washers for example).

**II—Punch.** Punch is mica used for small shapes. It must have a clear area of at least \( \frac{3}{4} \) sq. in. It ranges up to \( 1 \frac{1}{2}'' \times 2'' \), the smallest size classified as sheet.

**III—Sheet.** Mica yielding relatively clear and flawless sheets of an area of from \( 1 \frac{1}{2}'' \times 2'' \) is termed sheet. *Splittings* are thin sheets of at least \( \frac{3}{4} \) sq. in. in area from .001 to .0012 inches thick used in building up plates of "micanite."

A simplified size grading chart is shown in figure 6.
"Use of simplified grading chart.—The three concentric circles in figure 6A show the minimum area of small punch, punch, and circle, respectively. Place the mica so that the circle of the sound area is centered at O, and observe the relation of the circles to this area. If it is larger than the smallest circle and smaller than the intermediate it is classed as 'small punch'; if it is larger than the intermediate circle and smaller than the outer circle it is 'punch,' etc.

"For rectangular or square blocks place the mica so that the lower right corner of the sound area is at O, the smaller dimension of the sound area extending along the vertical line, and the larger dimension along the horizontal line. The largest rectangle on the chart that is completely within the boundaries of the sound area indicates the grade size. Each grade size includes mica of the designated minimum dimensions and smaller than the next larger size. A block or sheet the usable area of which is 1 1/2 by 2 1/2 inches is classed as 1 1/2 by 2 inches.... [larger sizes are not shown on this chart.]

"In many instances it will be well for the miner to prepare a grading chart suited to his specific needs. It must be remembered that the simplified chart shows only one dimension combination for each grade size. The minimum acceptable area for 2- by 2-inch sheets is 4 square inches and the maximum is 6 square inches. The smallest or minimum dimension in this grade is 1 inch. Thus, a strip of mica 1 inch wide may range from 4 inches to 6 inches in length. The following tabulation shows the combinations of dimensions that may be used to construct a 2- by 2-inch grading chart. The series of rectangles with a common point at O outline the smallest acceptable and largest areas economical in the 2- by 2-inch grade.

<table>
<thead>
<tr>
<th>Smallest or minimum area (4 sq. in.), inches</th>
<th>Largest or maximum area (6 sq. in.), inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 by 4</td>
<td>1 by 6</td>
</tr>
<tr>
<td>1 1/4 by 3 1/4</td>
<td>1 1/4 by 4 1/4</td>
</tr>
<tr>
<td>1 1/2 by 2 1/4</td>
<td>1 1/2 by 4</td>
</tr>
<tr>
<td>1 3/4 by 2 1/2</td>
<td>1 3/4 by 3 1/4</td>
</tr>
<tr>
<td>2 by 2</td>
<td>2 by 3</td>
</tr>
<tr>
<td></td>
<td>2 1/4 by 2 1/2</td>
</tr>
</tbody>
</table>

"Actually, the dimensions in the column at the left outline the upper limit to the 1 1/2- by 2-inch grade and the lower limit of the 2- by 2-inch grade, whereas the column at the right is the upper limit of the 2- by 2-inch grade and the lower limit of the 2- by 3-inch grade. Figure 6B is constructed with the above dimensions and may be used to grade 2- by 2-inch sheets. In actual practice operators become very proficient and grade by eye without actually measuring each piece." 4

Quality Gradings. The American Society for Testing Materials standards for quality follows: 5

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**CLASSIFICATION OF QUALITY OF MICA**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>Free of all mineral and vegetable inclusions, stains, air inclusions, waves or buckles. Hard transparent sheets.</td>
</tr>
<tr>
<td>Clear and Slightly Stained</td>
<td>Free of all mineral and vegetable inclusions, cracks, waves, and buckles, but may contain slight stains and air inclusions.</td>
</tr>
<tr>
<td>Fair Stained</td>
<td>Free of mineral and vegetable inclusions and cracks. Hard. Contains slight air inclusions and is slightly wavy.</td>
</tr>
<tr>
<td>Good Stained</td>
<td>Free of mineral inclusions and cracks but contains air inclusions, some vegetable inclusions, and may be somewhat wavy.</td>
</tr>
<tr>
<td>Stained</td>
<td>Free of mineral inclusions and cracks but may contain considerable clay and vegetable stains and may be more wavy and softer than the better qualities.</td>
</tr>
<tr>
<td>Heavy Stained</td>
<td>Free of mineral inclusions but contains more clay and vegetable stains than that of Stained Quality, and distinctly inferior as regards to rigidity and toughness.</td>
</tr>
<tr>
<td>Black Stained and Spotted</td>
<td>Apt to contain some mineral inclusions consisting of magnetite (black), specularite (red), and hydrous iron oxide (yellow).</td>
</tr>
</tbody>
</table>

Black-stained is sometimes separated into four qualities or classes. They are, in descending order of quality, showing increase in degree and distribution of staining: (1) Heavy-stained, (2) light-dotted, (3) black-spotted, and (4) black-stained. Black-stained contains varying proportions of iron or other metallic oxide in stains, streaks, or spots.  

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**APPROXIMATE COMPARISON OF DOMESTIC AND INDIAN CLASSIFICATION**

<table>
<thead>
<tr>
<th>Usual domestic qualities</th>
<th>Standard Indian qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>Clear</td>
</tr>
<tr>
<td>Clear and slightly stained</td>
<td>Clear and slightly stained.</td>
</tr>
<tr>
<td>Slightly stained</td>
<td>Slightly stained</td>
</tr>
<tr>
<td>Fair-stained</td>
<td>Fair-stained</td>
</tr>
<tr>
<td>Good-stained</td>
<td>Good-stained</td>
</tr>
<tr>
<td>Stained</td>
<td>Stained</td>
</tr>
</tbody>
</table>

No. 1 Clear. 
No. 2 Clear.

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ONSTRATEGIC

No. 1 Electric

Heavy-stained.

No. 2 Electric

Light-dotted.

{Black-spotted.

No. 3 Electric

Black-stained.

"Strategic mica, according to the present definition contained in War Production Board Order M-101, is block and punch mica of better than heavy-stained quality, free of mineral inclusions (black or red spots, stains, or streaks), cracks, pinholes, cross-grains, reeves, and ribs and relatively free of clay staining. It must be hard, clear, reasonably flat, and capable of being evenly and easily split into laminations or sheets... of at least 1 by 1 inch in size."\(^7\)

SOURCES OF SUPPLY

The United States has been self-sufficient in the production of scrap mica. For the better grades, however, we have been dependent on outside sources. There are several regions upon which we have drawn for sheet mica. India has been the largest source followed in recent years by Madagascar and Canada. A number of other regions are known to have deposits that can yield some strategic mica, but from which, to date, production has been small. Among these are: Argentina, Rhodesia, South Africa, and Brazil. India and Madagascar are remote, and with shipping at a premium, and production in India, the chief source, somewhat problematical at present, military exigency demands as much relief from dependence on the normal sources as possible. Increase of domestic production even at high cost seems to offer partial relief.

North Carolina, New Hampshire, and Connecticut have been the leading states producing sheet and punch mica for the past several years. Other states producing lesser amounts are Alabama, Arizona, California, Colorado, Georgia, Maine, New Mexico, New York, South Carolina, South Dakota, Vermont, and Virginia. In 1910 domestic production was estimated at 1,625,437 pounds of uncut sheet and punch mica. Under war stimulus, a larger percentage of our total requirement of sheet and punch mica can be met. We have been in virtually total dependence on splittings for built up products, and unless substitutes, not yet perfected, are brought into the picture, we must still draw a substantial amount of our mica splittings from outside sources.

\(^7\) Ibid., p. 3.
Prospects for Production of Strategic Mica in Maine. There are several considerations that must be made in evaluating mica prospects in this State:

1. Present indications. This includes abundance, distribution, sizes, and thickness of the visible mica books, and quality of the mica.

2. Past history of production, if any, of the deposit. Time and the elements, plus the activities of collectors and prospectors, may give a relatively disappointing aspect to deposits that have merit, as shown by past history of production.

3. Market conditions. The price of grades of mica producible at a locality is an important factor in judgment.

Price Schedule for Domestic Strategic Mica

<table>
<thead>
<tr>
<th>Size, inches</th>
<th>Price per pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>1½ by 2</td>
<td>$2.40</td>
</tr>
<tr>
<td>2 by 2</td>
<td>3.52</td>
</tr>
<tr>
<td>2 by 3</td>
<td>4.64</td>
</tr>
<tr>
<td>3 by 3</td>
<td>5.12</td>
</tr>
<tr>
<td>3 by 4</td>
<td>6.08</td>
</tr>
<tr>
<td>3 by 5</td>
<td>7.04</td>
</tr>
<tr>
<td>4 by 6</td>
<td>8.00</td>
</tr>
<tr>
<td>6 by 8</td>
<td>9.12</td>
</tr>
<tr>
<td>Punch</td>
<td>.30</td>
</tr>
</tbody>
</table>

“Punch mica must have a clear usable area of not less than 1” in diameter and total area of each piece shall not be greater than five times the usable area. Usable area shall be free from cracks or other visible defects. Discounts for sub-standard quality or trim. Bonus for refinements in trimming up to a maximum of 40% for full India trim. This scale does not apply to black stained or other nonstrategic mica.”

Note prices are for rifted and trimmed mica, not for mine run product. The price for mine run depends on quality and quantity of strategic mica present.

4. Governmental assistance. Technical assistance and lease of mining equipment, such as jackhammers, compressors, hoists, pumps, etc., can be obtained through the Colonial Mica Corpora-

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8 Prices and specifications issued by Colonial Mica Corporation, agent for Metals Reserve Corporation under R.F.C. These prices are guaranteed until December, 1943, by the corporation.
tion, agent for the Metals Reserve Corporation, at a rental basis of 2% per month based on cost on approved projects. Other assistance may be granted in certain cases. Colonial Mica is also purchasing agent, and miners are assured a market for mica of strategic grade.

5. Other production than strategic mica. The possibilities of production and sale, together with prices realizable on the other products, are of high importance. Feldspar, scrap mica, and beryl are the chief possibilities. It should be noted, however, that many of the best sheet mica deposits do not commonly yield much spar. During the past season the prices of scrap mica have varied from $20.00 to $25.00 a ton, of spar from $3.00 to $7.00 a ton, depending on quality. Beryl is currently priced at $100.00 a ton.

**Comments on a Few of the Mica Occurrences**

Several prospects examined appear to be capable of yielding a little mica of strategic grade.

**Guy Johnson Property, Albany.** This prospect is located about one-half mile northeast of the H. W. Stearns homestead. A course pegmatite has been worked for feldspar, and a small opening about 20' x 20' x 6' was made. There is some muscovite in books up to an observed maximum of 5" in diameter, 3" to 4" thick. The mica is somewhat warped, but some is of rifting quality. The mica is irregularly disseminated through the pegmatite. Good feldspar shows in bottom of pit, and some beryl in crystals up to 4" in diameter. This appears to be a feldspar prospect, with prospect of a little mica and beryl production. Northeasterly of the above mentioned opening are several pegmatite exposures, all of which appear to be non-commercial. Owner: Guy Johnson, Eaton, New Hampshire.

**L. G. Wardwell Property, Albany.** This property, situated on the farm of L. G. Wardwell, was in operation for mica at the time visited (August 28, 1942). A pegmatite dike with an estimated thickness of 40', strikes N. 70° W. In a distance of about 100 yards, six small openings have been made. The northwestern most of these was the pit under development. In this opening, on the west wall, muscovite is concentrated along a zone six to eight feet thick, which apparently dips westerly, as the zone does not
appear on the east wall. Biotite is present, and tends to strip form, 3” to 4” wide, 8” to 10” long. Muscovite occurs in books up to 8” to 10” in diameter; the average being 3” to 4”, thickness of the books, 1/2” to 2” exceptionally 4” or 5”. In the bottom of the pit are fair showings of feldspar. Some beryl is present in small crystals. Good mica showings are limited to the two northwesternmost openings. About 100 yards to the southeast, just west of the line of openings mentioned, is another small excavation; apparently in a separate pegmatite body, as granite gneiss intervenes. This shows on its western face a concentration of muscovite, which may be another vein. Foliation in the gneiss strikes N. 15 W., dips 40° westerly. J. Pichnik of South Paris, Maine, operator; L. G. Wardwell, Albany, Maine, owner.

Jeffrey LaChance Property, Brunswick. Two miles south of Brunswick on Highland Road. There are several openings on this farm that have been worked for feldspar and quartz. The easterly openings on this farm show a pegmatite dike about 30’ wide, striking north, apparently dipping west at about 60° beneath a biotite gneiss. On the east side of the dike is a fine to medium textured grey granite. The pegmatite margins the granite. The age relation between granite and pegmatite was not determined, possibly the pegmatite is a differentiate of the granite. Although mica is not very abundant, and not concentrated in any definite zone, some is of very good quality for rifting. It would be a relatively expensive operation, with small yield. (About one-fourth mile west of the preceding is a larger opening in pegmatite which has some beryl and columbite, as well as feldspar and quartz. This location has no mica prospects.) Owner: Jeffrey LaChance, Brunswick, Maine.

Hibbs Ledge, Hebron. The pegmatite is intruded into a biotite bearing lime silicate gneiss. The contact is well exposed along the west side of the quarry. The gneiss dips easterly at about 45°. A mica rich zone about four to six feet wide outcrops along the base of the west wall, dipping, by estimate at about 65° to horizontal beneath the west wall. The writer interprets the pegmatite body as a cross cutting dike dipping steeply to the west. (See figure 1 for cross section.) In the mica zone, books of mica measuring up to 8” or 9” on edge can be seen. Smaller books are more abundant. Much of the mica is ruled, but rifting mica up to 1 1/2” by 2”
is not uncommon. The mica is of good quality, amber colored. The mine has a good history of production of spar, mica, and a limited amount of beryl. Properly operated this deposit would seem to have some promise. Owner: Dr. George Hibbs, Bath, Maine.

**Saunders Property, North Waterford.** This property is located on the northeast slope of Beach Hill, about one mile south of North Waterford village. The chief opening, really a test pit, shows blocky feldspar and quartz in masses up to two feet in diameter. Some large mica crystals present, maximum observed about 12 inches in diameter. Mica in books up to four to five inches in diameter common, some are three to four inches thick. There is some showing of beryl. The dimensions and altitude of the dike were not determined. This is a fair feldspar prospect, with mica and beryl possibilities. United Feldspar and Minerals Corporation, West Paris, Maine, lease-holder.

![Figure 7. Cross-section of Mt. Mica Mine](image)

**Mt. Mica, Paris.** This well-known property is situated about one and one-half miles east of Paris village. The locality is famous because of its early production of fine tourmalines. It was worked for mica with indifferent success in 1873. The pegmatite is apparently concordantly intruded into mica schists. See figure 7. The schistosity and contact of schist and pegmatite dip southeasterly about 25° to 35°. There does not appear, from present exposures, to be a concentrated mica zone or "vein." The mica, some of which is of good quality, is irregularly scattered through the pegmatite. Books up to 5" to 6" in diameter, \(\frac{1}{2}" to 2"\) thick are fairly common. Unfortunately the dump from the gem workings rests on top of the pegmatite body. Reworking and removing the dump would be indicated if further development were attempted. The possibili-
ty of further gem production, mineral specimens, and the commercial feldspar prospects give the deposit special interest. Owner: Howard Irish, Buckfield, Maine.

Old Mica Farm, Peru. This pegmatite lies on the steep west slope of Hedgehog Hill. There are two openings, the earlier one lies just south of the more recent working. The rock is a coarse pegmatite with abundant muscovite and biotite irregularly disseminated through the deposit. Some of the muscovite books measure up to 6” on an edge, with thicknesses noted up to 2”. Some of the biotite is intergrown with muscovite, and the long narrow strip or ribbon-like character of the biotites is striking. Some of the ribbons measure up to 5’ in length, being a few inches wide. The country rock is biotite gneiss; and the inferred structure of the deposit is that of a concordant lens. While there is a limited amount of mica of rifting quality, in the smaller grades, the dissemination of the mica through the deposit insures a high cost operation. A minor amount of beryl and garnet are found. The outlook for feldspar is not bright because of the admixed mica. Owner: Howard Irish, Buckfield, Maine.

Beach Hill Mica Mine, Waterford. This abandoned mica mine lies about 550 yards S. 45° E. of the old Kimball farm house on Beach Hill. A pegmatite dike strikes about N. 20° W., making a prominent esker-like ridge south of the main opening. The pegmatite is margined by granite of irregular texture. Both biotite and muscovite are present, the biotite tending to strip form, several measured 1” by 10”. Muscovite is especially abundant in a zone four feet thick along the east wall of the workings. It dips about 35° to the east, and probably follows the contact zone of the pegmatite. Mica constitutes about 20% of this zone. Many of the muscovite crystals measure about 3” in diameter, and from 1/2” to 2” thick. There is little strategic mica in evidence at the present time; and weathering renders the prospect less attractive than if the rock surfaces were fresh. Ruling and wedge structure are common defects here. From 1900 to 1902 the mine produced about a ton of sheet mica. No data on subsequent operation are available. The mine has certainly been idle for some years. Because of its history as a producer, favorable aspects when not long abandoned,9

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and an assured production of scrap mica, the property merits some exploratory development. The feldspar prospects are not promising. Owners: D. R. Kimball and George Packard, South Waterford, Maine.

**Willis True Prospect, Waterford.** This prospect lies about one-half mile west of Duck Pond. A small opening measuring approximately 12' x 15' x 5' has been made in coarse pegmatite. The pegmatite dike appears to strike about N. 20° W. following trend of schlieren in the granite, which is exposed just south of the opening. Mica appears more abundant in small opening about 50' south of the first excavation. The full width of the pegmatite vein is not exposed, but is estimated at, at least, 40', with a length of probably, at least, 100'. True reports that he took about 100 pounds of mica and six tons of spar out of the northerly excavation. The mica occurs in small books averaging less than 3½" in diameter. It appears in part to be of excellent quality, and should yield good punch or small grades of sheet. If True's figures are not overestimated, a relatively high proportion of the rock moved was sold as spar. Trenching to expose the vein and several shots are needed to prove the vein. The mica is apparently disseminated in the pegmatite. Owner: Willis True, Portland, Maine.

**Warren Davis Property, West Bath.** Three small pits, in this property, were examined. Apparently the mica-bearing pegmatite dike strikes northwesterly, and probably dips southerly, though this could not be determined. In the northwesterly pit, which measured 10' x 10' x 5', a 2' zone with abundant mica was exposed on south and east wall. Some of the mica is of good splitting quality. About a pound of golden beryl was picked up from this pit, but none was seen in place. Feldspar prospects are not encouraging. Volume as shown appears limited but deposit merits exploratory work. (Since this deposit was visited in July, development has been undertaken by Mr. Herman Sappola. Owner: Mrs. Warren Davis, West Bath, Maine.)

**Summary**

The descriptions of the properties given above are not arranged according to quality. The best prospect for sheet mica production appears to be the Hibbs mine, Hebron. It will be noted that several of the properties have some good mica disseminated
through the rock rather than concentrated in zones. Operational costs for mica mining in the cases of disseminated mica are higher than those cases where a mica-rich zone occurs. In terms of the manpower situation it is doubtful if these disseminated mica deposits should be operated for mica. If the feldspar produced is merchantable, the prospect is more attractive. No mining venture is ever a sure-fire proposition. However, if no holes were ever started or operations initiated except under optimum conditions, we should have a scant mineral output. Probably in normal times, no one of these prospects could stand on its own feet as a mica development.

Observations to date indicate only a limited amount of good quality rifting and punch mica. These will be high cost operations, and large profits are not to be expected. Much ground remains to be covered, however, and many prospects have not yet been visited.

**SUMMARY REPORT ON THE INVESTIGATION OF MANGANESE OCCURRENCES IN AROOSTOOK COUNTY, MAINE**

At the instigation of the New England Council, Governor Sewall, in June, 1941, called together a group of representatives of the New England Council and other parties interested in mineral resources of Maine. At this meeting the critical position of manganese in our national economy was pointed out, and the occurrences of manganese in Aroostook County noted. On the recommendation of this group, the examination of the Aroostook occurrences of manganese was authorized in June, 1941, and five thousand dollars for this purpose was made available.

The work was placed under the State Military Defense Commission, R. T. Adams, Director, and Mr. Paul Eckstorm was hired to carry on the field investigation. In August, Dean Paul Cloke, University of Maine, was appointed to supervise the investigation. Mr. Donald Guernsey, Massachusetts Institute of Technology, is responsible for the chemical analyses. Dr. A. M. Gaudin, of the Massachusetts Institute of Technology, acted in an advisory capacity throughout the investigation and carried out preliminary research on the extraction of the manganese.
Prior to this time several investigations of the manganese occurrences had been made by others. C. T. Jackson\textsuperscript{10} in his second report described a manganiferous hematite bed on the Aroostook River. His analysis shows:

\begin{align*}
\text{H}_2\text{O} & \quad 6.00 \\
\text{Fe}_2\text{O}_3 & \quad 76.80 \\
\text{MnO}_2 & \quad 8.20 \\
\text{Insoluble} & \quad 8.80 \\
\hline
& \quad 99.80
\end{align*}

This occurrence has not been relocated. The deposit was estimated to contain 194,400 T of ore. Olaf A. Nylander has visited many of the occurrences of manganiferous beds. The Bethlehem Steel Company had made a geological examination of deposits in the Hodgdon area in 1928. An analysis furnished by that company shows 40% Fe and 5% Mn. In 1939, Paul Eckstorm, employed by the B. & A. R.R., visited localities in Hodgdon, Castle Hill, Mapleton, Ashland, and New Sweden. In 1941, the U. S. G. S. had a party in the area. A preliminary map of this work is now available.

Mr. Eckstorm spent four months in the Aroostook area during the field season of 1941. Some seventy-seven outcrops were visited. The more promising beds were further exposed by trenching, and channel samples taken. Channel samples were taken across the beds from the trenches. In some instances these represent the full width of the manganiferous beds. From some of the trenches certain portions were selected for channeling. So far as practicable the trenches were dug across the strike. The samples taken were shipped to the laboratories of Massachusetts Institute of Technology and partial analyses determining the percentages of Mn, Fe, P, S, and insolubles were run by Mr. Donald Guernsey.

\textbf{PRINCIPAL RESULTS OF THE INVESTIGATION}

In the following paragraphs only a summary of the more important findings is presented. In tabular form these data are

presented as Table 1, and a tabulation of the available chemical analyses made to date is given as Table 2.

**Geographic Distribution**

Manganese bearing beds occur in two distinct districts. The southern of these has outcrops of the beds in Houlton, Hodgdon, Amity, Linneus, and Littleton. In the more northerly district, outcrops are exposed in Mapleton, Castle Hill, Ashland, Wade, Perham, Woodland, and New Sweden. It is probable that these beds occur as elongate lenses. Five principal occurrences have been investigated. These are located in Hodgdon, Linneus, TCR 2, Castle Hill, and New Sweden.

**Grade and Volume of the Deposits**

Table I shows a summary of the results of the analyses of these five principal occurrences. For the five major occurrences the average manganese content at the surface is about eight per cent. This figure is probably somewhat too low, as shown by subsequent analyses, and represents some dilution of the samples with the non-manganiferous beds adjacent.

<table>
<thead>
<tr>
<th>Location</th>
<th>% Mn</th>
<th>% Fe</th>
<th>% P</th>
<th>% S</th>
<th>% Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dudley Farm, Castle Hill</td>
<td>10.73</td>
<td>21.8</td>
<td>.82</td>
<td>.03</td>
<td>35.2</td>
</tr>
<tr>
<td>Hemborg Farm, New Sweden</td>
<td>8.07</td>
<td>24.8</td>
<td>1.04</td>
<td>.05</td>
<td>26.4</td>
</tr>
<tr>
<td>Stewart Farm, Linneus</td>
<td>7.25</td>
<td>25.3</td>
<td>.60</td>
<td>.09</td>
<td>31.3</td>
</tr>
<tr>
<td>Thwaites Farm, Hodgdon</td>
<td>8.10</td>
<td>19.1</td>
<td>.67</td>
<td>.11</td>
<td>43.7</td>
</tr>
<tr>
<td>Township C, Range 2</td>
<td>6.5</td>
<td>25.2</td>
<td>N.D.</td>
<td>N.D.</td>
<td>29.1</td>
</tr>
</tbody>
</table>

Estimation of tonnage of manganese bearing rock is not possible until data can be made available as to grade in depth. The manganese oxide coatings on partings and fractures are secondary, the result of surficial agencies. If a depth figure of twenty feet is assumed, using Eckstorm's measurements of areal extent and his figure for specific gravity, 3.5, a total tonnage of over 2,000,000 T of oxide ore is indicated for the five major occurrences as listed in Table 1. Should areal extent prove greater on stripping, this ton-
nange estimate may be increased. If metallurgical difficulties can be overcome, rendering the deeper unoxidized portions usable, these tonnage estimates can be increased manyfold.

Geology of the Manganese Bearing Beds

Mineralogy. No mineralogical study of the manganese-bearing rocks has yet been made available. Prof. A. M. Gaudin, on inspection of polished specimens, reports psilomelane and pyrolusite as the chief manganese bearing minerals. Rhodocrosite is present in minor amounts in most of the occurrences near Houlton, at Castle Hill, Mapleton, and New Sweden. The U. S. Geological Survey reports the presence of manganese silicates. Oxidation extends to a depth of about twenty feet, below which depth the manganese oxides are minor. The carbonate occurs as small veins and disseminated grains, and the manganese silicates, which appear to be the primary manganese minerals, occur in thin beds. The shales are hematitic. In the Houlton area, magnetite is abundant. Megascopically, manganese oxide staining and thin coatings on shaley partings and fracture surfaces are the most obvious occurrences.

Stratigraphy. Work by the U. S. Geological Survey has confirmed the Clinton age of the manganese bearing beds. In the Houlton area, it is lithologically similar to the Woodstock Iron Formation (Clinton) of New Brunswick. The best marker horizons are the hematitic beds. Exact correlation of the individual districts is not established.

Structure. As the regional structure has not yet been worked out, only a few generalities can be stated. In the Houlton area, the beds are highly deformed. Axes of the minor folds show considerable variation in trend and pitch. Numerous faults are probably present. In the northern area (Mapleton, Castle Hill) the folding does not appear so intricate but faulting complicates the structure.

Origin of the Deposits. Enough data are not as yet available to permit conclusions as to the origin of the deposits. The manganese bearing beds are sedimentary marine formations. It may be suggested that volcanic emanations contributed iron and manganese to the sea waters of the area giving rise to the iron-manganese formation in a way analogous to the Lake Superior iron forma-
tions. The carbonate in the veins probably does not represent any extensive migration or enrichment of manganese. Recent oxidation above the water table accounts for the staining.

**Laboratory Work on the Recovery of the Manganese**

Some metallurgical work of an exploratory nature has been done by Prof. A. M. Gaudin on material from the Dudley Farm, Castle Hill. This preliminary work indicates that a leaching process is best adapted to the manganese extraction. The possibility of recovering an iron concentrate from the leach residue is also indicated.

**SUMMARY**

The investigation to date demonstrates the presence, in Aroostook County, Maine, of surficial deposits of some two million tons of manganese bearing shales and iron formation averaging over eight per cent manganese. The Manganese Ore Company has been carrying on an extensive drilling program in Castle Hill and has shipped several bulk samples for metallurgical investigation. The results of their work are not yet available. If a successful treatment for this low grade siliceous material can be worked out in the near future, a large scale development of this resource appears probable.
<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Sample</th>
<th>% Mn</th>
<th>% Fe</th>
<th>% P</th>
<th>% S</th>
<th>% Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHLAND</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outcrops in Frenchville district. On east slope of next hill east from Frenchville church, 100 yds. north of road.</td>
<td>38' sample</td>
<td>5.7</td>
<td>10.6</td>
<td></td>
<td></td>
<td>30.7</td>
</tr>
<tr>
<td></td>
<td>Part of above.</td>
<td>72' sample</td>
<td>14.2</td>
<td>15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HODGDON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickerson Farm</td>
<td>In south Hodgdon on Calais Road ½ mile north of the Hodgdon-Cary town line.</td>
<td>48' sample</td>
<td>9.0</td>
<td>14.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>At the roadside south of the farm buildings.</td>
<td>88' sample</td>
<td>8.13</td>
<td>27.0</td>
<td>0.55</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>Nearly 150 yds. east of Outcrop #1 and but a short distance southeast of the ruined Nickerson barn.</td>
<td>88' sample</td>
<td>11.5</td>
<td>20.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A part of the above trench.</td>
<td>50' sample</td>
<td>5.33</td>
<td>10.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baggett Hill</td>
<td>On lower road to the Jackins Settlement ½ mile east of Calais Road.</td>
<td>15' sample</td>
<td>9.6</td>
<td>20.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haskell Farm</td>
<td>On Calais Road near west end of Westford Hill.</td>
<td>7' sample</td>
<td>7.68</td>
<td>18.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In old pit east of Calais Road about 350 yards.</td>
<td>7' sample</td>
<td>7.38</td>
<td>14.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Part of above.</td>
<td>5' sample</td>
<td>5.13</td>
<td>10.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>About 300 yards north of #1.</td>
<td>5' sample</td>
<td>5.13</td>
<td>10.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand Farm</td>
<td>On top of Westford Hill near the saddle and on the south slope of eastern peak of hill.</td>
<td>46' sample</td>
<td>8.88</td>
<td>15.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 yards southwest of old buildings on Hand Farm.</td>
<td>43' sample</td>
<td>8.5</td>
<td>20.8</td>
<td>0.82</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>Nearly ¼ mile south of No. 1 and slightly to east.</td>
<td>43' sample</td>
<td>10.0</td>
<td>23.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Part of the above trench.</td>
<td>43' sample</td>
<td>10.0</td>
<td>23.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Part of the above trench.</td>
<td>Magnetite bed</td>
<td>8.32</td>
<td>16.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Part of the above trench.</td>
<td>Black shale</td>
<td>12.7</td>
<td>25.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>150 ft. southeast of No. 2.</td>
<td>80' sample</td>
<td>10.5</td>
<td>25.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>On side of knoll near south end of pasture.</td>
<td>12' sample</td>
<td>8.8</td>
<td>18.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thwaites Farm</td>
<td>West side of Henderson Hill south of cross road at East Hodgdon.</td>
<td>12' sample</td>
<td>8.8</td>
<td>18.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 2—(Continued)

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Sample</th>
<th>Mn</th>
<th>Fe</th>
<th>P</th>
<th>S</th>
<th>Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main occurrence extends from southwest corner of Thwaites Farm for 1/2</td>
<td>25' sample</td>
<td>9.1</td>
<td>19.5</td>
<td></td>
<td></td>
<td>41.3</td>
</tr>
<tr>
<td>mile slightly east of north over summit of hump of hill and down north</td>
<td>west end</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>slope halfway to road.</td>
<td>50' sample</td>
<td>8.6</td>
<td>19.6</td>
<td></td>
<td></td>
<td>42.0</td>
</tr>
<tr>
<td>Center trench, part of above.</td>
<td>center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North trench, part of above.</td>
<td>24' sample</td>
<td>7.5</td>
<td>19.4</td>
<td></td>
<td></td>
<td>40.6</td>
</tr>
<tr>
<td>South trench, part of above.</td>
<td>east end</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor outcrops occur in the small wooded area at northeast corner</td>
<td>65' sample</td>
<td>7.9</td>
<td>29.4</td>
<td>0.67</td>
<td>0.11</td>
<td>42.3</td>
</tr>
<tr>
<td>of the farm.</td>
<td>west end</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>George H. Benn Farm</td>
<td>65' sample</td>
<td>6.3</td>
<td>16.8</td>
<td></td>
<td></td>
<td>59.2</td>
</tr>
<tr>
<td>Northwest corner of Hodgdon about 1 1/2 miles from Hodgdon village on</td>
<td>east end</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>western road of two roads to Cary's Mills.</td>
<td>40.5' sample</td>
<td>7.0</td>
<td>17.4</td>
<td></td>
<td></td>
<td>45.7</td>
</tr>
<tr>
<td>In wide field on west side of road about 3/4 mile from road.</td>
<td>west end</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOULTON</td>
<td>21.5' sample</td>
<td>16.5</td>
<td>18.3</td>
<td></td>
<td></td>
<td>42.1</td>
</tr>
<tr>
<td>Harkins Farm, Hovey Hill</td>
<td>W. Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southwest slope of Hovey Hill</td>
<td>10' sample</td>
<td>6.1</td>
<td>15.9</td>
<td></td>
<td></td>
<td>40.6</td>
</tr>
<tr>
<td>Along steep ridge which rises abruptly from swampland at base of hill.</td>
<td>East Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On face of bluff.</td>
<td>43' sample</td>
<td>7.8</td>
<td>20.5</td>
<td></td>
<td></td>
<td>38.3</td>
</tr>
<tr>
<td>Near north line-fence of Stewart Farm, somewhat east of first trench</td>
<td>east end</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and about 100' to the north.</td>
<td>21' sample</td>
<td>7.7</td>
<td>18.6</td>
<td></td>
<td></td>
<td>45.8</td>
</tr>
<tr>
<td>Brewer Farm</td>
<td>23' sample</td>
<td>8.6</td>
<td>21.0</td>
<td></td>
<td></td>
<td>32.3</td>
</tr>
<tr>
<td>North of Adams Mountain and north of country cross-road which passes the</td>
<td>17' sample</td>
<td>8.7</td>
<td>19.7</td>
<td></td>
<td></td>
<td>32.8</td>
</tr>
<tr>
<td>Adams Farm.</td>
<td>25' sample</td>
<td>8.3</td>
<td>26.1</td>
<td>1.38</td>
<td>0.11</td>
<td>28.5</td>
</tr>
<tr>
<td>At roadside immediately in front of buildings of Adams Farm and west of</td>
<td>CaO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>those of Brewer Farm itself.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAPLETON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. R. Higgins Farm</td>
<td>47.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toward back (north) of the large field cast of buildings, short distance</td>
<td>44' sample</td>
<td>7.0</td>
<td>30.7</td>
<td></td>
<td></td>
<td>23.6</td>
</tr>
<tr>
<td>east of farm road which crosses R. &amp; A.</td>
<td>43' sample</td>
<td>7.5</td>
<td>19.8</td>
<td>0.69</td>
<td>0.09</td>
<td>38.9</td>
</tr>
<tr>
<td>R. R. tracks.</td>
<td>25' sample</td>
<td>8.3</td>
<td>26.1</td>
<td>1.38</td>
<td>0.11</td>
<td>28.5</td>
</tr>
<tr>
<td></td>
<td>23.4' sample</td>
<td>17.6</td>
<td>25.4</td>
<td>0.88</td>
<td>0.14</td>
<td>28.8</td>
</tr>
</tbody>
</table>
TABLE 2—(Continued)

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Sample</th>
<th>% Mn</th>
<th>% Fe</th>
<th>% P</th>
<th>% S</th>
<th>% Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part of above.</td>
<td>3' sample</td>
<td>28.1</td>
<td>10.5</td>
<td>16.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part of above.</td>
<td>8' sample</td>
<td>25.4</td>
<td>11.8</td>
<td>26.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part of above.</td>
<td>1.2' sample</td>
<td>19.7</td>
<td></td>
<td></td>
<td>Not assayed</td>
<td></td>
</tr>
</tbody>
</table>

Dudley Farms

Southeast corner of Castle Hill on
highway which runs from Mapleton-
Ashland Road to the Pyle School.
Frands Dudley Farm lies to south
side of road near top of hill. Milton
H. Dudley Farm is on north side of
road near base of hill on west slope.
Outcrops occur at the three trench
locations: one near north limit, second
behind the M. H. Dudley buildings,
third in gravel pit in edge of ravine
about 3/4 mile south of highway.

Middle trench, part of above.

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Sample</th>
<th>% Mn</th>
<th>% Fe</th>
<th>% P</th>
<th>% S</th>
<th>% Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>West end</td>
<td>72' sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East end</td>
<td>97' sample</td>
<td>8.5</td>
<td>23.7</td>
<td>36.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West end</td>
<td>66' sample</td>
<td>10.6</td>
<td>24.0</td>
<td>32.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East end</td>
<td>85.7' sample</td>
<td>13.3</td>
<td>22.9</td>
<td>32.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West end</td>
<td>44.3' sample</td>
<td>4.9</td>
<td>16.9</td>
<td>61.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East end</td>
<td>29.6' sample</td>
<td>9.1</td>
<td>18.1</td>
<td>35.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West end</td>
<td>16.8' sample</td>
<td>5.5</td>
<td>8.6</td>
<td>60.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West end</td>
<td>5.5' sample</td>
<td>5.2</td>
<td>18.1</td>
<td>25.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East end</td>
<td>3.4' sample</td>
<td>14.0</td>
<td>28.5</td>
<td>18.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

South trench, part of above.

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Sample</th>
<th>% Mn</th>
<th>% Fe</th>
<th>% P</th>
<th>% S</th>
<th>% Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>East end</td>
<td>17.6' sample</td>
<td>14.0</td>
<td>28.5</td>
<td>18.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West end</td>
<td>50' sample</td>
<td>14.0</td>
<td>28.5</td>
<td>18.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East end</td>
<td>Sample from</td>
<td>2.5</td>
<td>17.0</td>
<td>27.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West end</td>
<td>Sample from</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East end</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Guliford Smith Farm

On north road between Presque Isle
and Ashland 3/4 mile west of Dudley
Road.

At crest of ravine to the east.

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Sample</th>
<th>% Mn</th>
<th>% Fe</th>
<th>% P</th>
<th>% S</th>
<th>% Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>West end</td>
<td>39.4' sample</td>
<td>9.2</td>
<td>17.0</td>
<td>44.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NEW SWEDEN

Capitol Hill

August Anderson Farm

On northwest and north slopes of
Capitol Hill.

In extreme northeast corner of
the back field.

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Sample</th>
<th>% Mn</th>
<th>% Fe</th>
<th>% P</th>
<th>% S</th>
<th>% Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>South end</td>
<td>32' sample</td>
<td>16.9</td>
<td>5.2</td>
<td>52.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 2—(Concluded)

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Sample</th>
<th>Mn %</th>
<th>Fe %</th>
<th>P %</th>
<th>S %</th>
<th>Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part of above trench.</td>
<td>45.8' sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot; &quot; &quot; &quot; &quot;</td>
<td>north end</td>
<td>12.1</td>
<td>18.6</td>
<td></td>
<td></td>
<td>39.2</td>
</tr>
<tr>
<td>&quot; &quot; &quot; &quot; &quot;</td>
<td>north end, Fe.</td>
<td></td>
<td></td>
<td>12.3</td>
<td>29.7</td>
<td>33.3</td>
</tr>
<tr>
<td>Hemberg Farm</td>
<td>16' sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On west slope of Gelo's Hill</td>
<td>Hemberg Farm</td>
<td>8.4</td>
<td>27.3</td>
<td></td>
<td></td>
<td>29.3</td>
</tr>
<tr>
<td>and is the second farm on east side of road</td>
<td>4' sample</td>
<td>9.6</td>
<td>18.5</td>
<td>1.64</td>
<td>0.65</td>
<td>36.4</td>
</tr>
<tr>
<td>and first farm with buildings.</td>
<td>45' sample</td>
<td>8.9</td>
<td>29.0</td>
<td></td>
<td></td>
<td>29.0</td>
</tr>
<tr>
<td>On high pinnacle of Gelo's Hill which forms</td>
<td>55' sample</td>
<td>8.9</td>
<td>25.6</td>
<td></td>
<td></td>
<td>25.2</td>
</tr>
<tr>
<td>the southeast corner of back Hemberg Field.</td>
<td>52' sample</td>
<td>12.2</td>
<td>26.2</td>
<td></td>
<td></td>
<td>26.8</td>
</tr>
<tr>
<td>Farm to south.</td>
<td>17.6' sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm to SE end.</td>
<td>Hemberg Farm,  Center.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>About 100 yds. from south edge of field.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERHAM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In village of Perham itself, opposite church,</td>
<td>35.6' sample</td>
<td>7.6</td>
<td>13.0</td>
<td></td>
<td></td>
<td>44.3</td>
</tr>
<tr>
<td>in hillside south of highway.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>About 1¼ miles east of north from #1 and</td>
<td>35.6' sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lies west of north-south cross road</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>designated on topographic map.</td>
<td>TOWNSHIP C RANGE 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locations not established.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

33
LIST OF INDIVIDUAL PROPERTIES VISITED, 1942

Albany
Guy Johnson
Mrs. A. Nutting
Fred Scribner
H. W. Stearns

Ashland
Alcide Morin

Bath
W. Dunton Heirs

Brunswick
Jeffrey LaChance

Buckfield
Brown Mountain

Byron
Swift River

Castle Hill
Chandler Farm
M. F. Dudley properties

Cherryfield
Lead and Zinc Mine

Cooper
Cooper Hill

Cutler
Davis Beach

Edgecomb
Williams property

Georgetown
Town Quarry

Grafton
Old Spec Mountain

Hebron
George Hibbs
A. Sturtevant

Houlton
Brewer Farm
Harkins Farm

Lewiston
E. R. Wentworth

Littleton
A. Henderson

Machiasport
Harlan Holmes

Mapleton
R. R. Higgins Farm

Minot
Frank Conroy property

Montville
H. McCorrison

Newcastle
J. B. Shattuck

Newry
Plumbago Mountain
United Feldspar Co. property

New Sweden
August Anderson
Hemberg Farm

Peru
Hedgehog Hill

Phippsburg
Eric Carlson property
T. Colby Farm
Mrs. R. E. McIntyre property
Thistle Farm
Ed. Thomas property
Town Quarry
Miles Weber

Presque Isle
Jerry Glidden

Rumford
Black Mt., A. Alexander Heirs

Rumford Center
Glassface Mountain
South Brunswick
  Mrs. J. E. Dow

South Paris
  L. G. Wardwell

South Waterford
  W. True property

Standish
  A. F. Whitney property

Stoneham
  Lord Hill, National Forest

Township 10
  Catherine Hill

Union
  Paul Harriman

Warren
  H. G. Starret
  E. Starrett

Waterford
  Kimball & Packard
  United Feldspar Company

West Bath
  Mrs. Warren Davis

West Minot
  Will Dennis property

West Pembroke
  Clara A. Barrett Farm
  Maine Mining & Development Co.
    (Big Hill)

West Stoneham
  W. Warren

Wilton
  E. Rolfe

Windham
  Dundee Falls, Cumberland County
  Power and Light Company

Winslow
  Tin Mine (Holman Heirs)
  H. S. Howard Farm
  Fred Bigney Farm