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AN INVESTIGATION OF GARNET FROM THE SUDBURY AREA, ONTARIO

by

J. S. ROSS

INDUSTRIAL MINERALS DIVISION

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SUMMARY OF RESULTS

Garnet from the River Valley, Page and MacDonald garnet deposits in Dana and Loughrin townships, Sudbury area, were studied in detail, concentrated, beneficiated and compared for their abrasive qualities with that currently being consumed by a leading Canadian manufacturer of coated abrasives. Two important abrasive properties, the abrasive effect and rate of breakdown of the coated sized garnet concentrates have not been tested. These can be determined only by individual producers of coated abrasives.

Garnet concentrates from the Sudbury area, 35 to 65 mesh in size, have similar particle shapes, better capillarity properties and a greater rate of breakdown than garnet of a similar size being consumed by the same manufacturer. Of the natural Sudbury samples tested, sample D from the central zone of the River Valley deposit has the best of the tested abrasisive properties. Heat treatment of sample D at 1,400°F for 1/2 hour increased the relative capillarity to 51 percent and the rate of breakdown to 12 percent above that of the CSP garnet. The above results apply only to concentrates recovered by a dry milling process or a wet milling process employing no additives.

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INTRODUCTION

The garnet deposits of the Sudbury area in northern Ontario have been known for many years. Although they have been prospected and examined on numerous occasions, only one genuine attempt was made to mine one of these, the River Valley deposit in Dana township. Because of the surficial extent and garnet content of some of these deposits it was decided to compare the abrasive properties of the garnet from three of the occurrences with that being marketed. In addition, it was planned to determine the best method of improving the abrasive quality and to compare this beneficiated garnet with that being consumed in Canada.

Canada does not produce garnet and consumes slightly more than 300 tons a year. World production was 10,454 short tons in 1956. More than 90 percent of the world's consumption of garnet employed for technical uses is produced by Barton Mines Corporation near North Creek, New York State, United States. The deposit being mined near North Creek contains 10 to 12 percent garnet.

There are two types of uses for garnet in the abrasives industry: technical and non-technical. Technical uses are those involving polishing, smoothing, and grinding with either loose grains or coated cloth or paper. The main non-technical use is in sandblasting. Garnet is used in coated abrasives for abrading wood, leather, rubber, plastics, brass, and grinding valves; and in grains for polishing glass and stone.

THE GARNET DEPOSITS

Garnet, commonly associated with kyanite, occurs in many places along a general northeasterly-trending belt in Dryden, Awrey, Street, Loughrin and Dana townships in the Sudbury and Nipissing Districts. The host rocks, normally coarse-grained schists and gneisses, are of the Precambrian Grenville series and consist, mainly, of biotite, quartz and plagioclase. In most deposits, garnet is more abundant in the rocks containing higher proportions of mafic minerals.

MacDonald Deposit

The MacDonald zone, easily accessible by road, is 3 miles north of Markstay, Ontario and mainly in the west half of lot 12, concession I, Loughrin township. The deposit consists of garnetiferous biotite gneiss, has an approximate width of 100 feet, and has been traced for about half a mile. The zone strikes northwest and contains pink almandite garnets ranging from an average of 1 to 1 1/2 inch in size at the northeast contact to 1/4 inch at the other contact. The garnet crystals are well formed and contain various amounts of inclusions. Macroscopically, the larger crystals appear to contain a greater proportion of inclusions than the smaller ones. On outcrop surfaces, the larger crystals are weathered off smoothly and in cases contain pitted surfaces. These seem less suited for abrasive uses than the larger garnet in some of the other deposits noted below. On the other hand, the pea-shaped garnets, although sometimes rounded are only slightly weathered and stand out on the outcrop surface.

Page Deposit

The Page deposit is easily accessible and 5 1/2 miles north of Markstay, Ontario in the north half of lot 14, concession III, Loughrin township. When visited during June, 1957 the property was optioned by Industrial Garnet Company Limited of Sudbury. Here, a series of garnetiferous outcrops occurring as knolls were traced along a general northwesterly strike for approximately 800 feet. It is possible that this zone extends for a greater distance to the northwest and to the southeast.

The zone is a light grey, medium-grained, garnetiferous quartz-biotite gneiss conformable to Precambrian granite gneiss country rock. It has a much lower proportion of mafic minerals than the other two deposits mentioned in this report. Because of the highly contorted nature, the dip varies but averages 70 to 80 degrees east. Exposed areas containing the higher pink garnet concentrations vary from 20 to 90 feet in width and contain from 10 to 60 percent garnet up to 5 inches and averaging 1/2 to 1 inch in size. Approximately 25 percent biotite and minor kyanite are present with the remaining material being mainly quartz. Garnet occurs in moderately well-formed crystals, appears to have relatively few inclusions, and has been subjected to a higher grade of metamorphism than that in the other two deposits.

River Valley Deposit

The River Valley deposit is in the claim group S 45216, S 45217 and S 45218 in Dana township, Nipissing District. It is immediately west of the boundary between mining claims S 45217 and S 45216 and may be reached by a 5-mile jeep road north from River Valley. This garnet property, comprised of 100 acres, was previously controlled by Cubar Uranium Mines Limited and has been acquired by staking by Industrial Garnet Company Limited. From 1943 to 1949, Niagara Garnet Company quarried the zone on a limited scale and produced garnet concentrates in a mill at Sturgeon Falls.

The occurrence consists of a garnetiferous zone of mica schist conformable to the enclosing biotite granite gniess and striking north 50 degrees west with dips of 70 to 80 degrees southwest. At one exposed place the horizontal width is 225 feet. Although the writer traced the deposit for a length of 500 feet, the zone is probably much longer. A pit, 90 feet long and up to 30 feet wide and 30 feet deep has been excavated near the hanging wall of the garnet zone. Approximately 40 to 50 percent of the zone contains poorly-formed pink garnets up to 7 inches and averaging 1 inch in size, and containing a moderate amount of inclusions.

PETROGRAPHY

On the suggestion of the writer, Mr. H. F. Wiemer took seven samples from different parts of the three garnet deposits and sent them to Ottawa for examination. Each was taken from the bottom of a freshly blasted test pit. These samples contained garnet representative of the quality of garnet in the parts of the zones from which they were taken and did not necessarily contain a garnet or kyanite content representative of the whole deposit.

The eighth sample in the following list was taken from a collection of garnet crystals in the old pit in the central part of the River Valley deposit.

No.	Deposit	Location in deposit	Depth	Weight	Lump Size
A	MacDonald	Centre of coarse part	4-6'	55 lb.	-10 inches
B	River Valley	Northeast part	5-8'	72	-10
C	Page	Near southeast end	4-6'	53	-10
D	River Valley	Central part	5-8'	75	-14
E	River Valley	Southwestern part	5-8'	74	-10
F	Page	Near northwestern end	6'	56	-10
G	MacDonald	Centre of fine part	4-6'	64	-10
RV	River Valley	Old pit	Surface	100	-5

Macroscopy

Sample A: Rock -- dark grey, medium to coarse-grained quartz-biotite schist with 40% biotite, 25% garnet, 17% amphibole, 15% quartz, with the remainder consisting mainly of fine-grained muscovite. Higher grade concentrations occur in zones rich in biotite and amphibole.

Garnet -- lavender, moderately vitreous, granular texture, moderate coating of biotite with some muscovite, chlorite and tremolite; 3 to 5 percent inclusions of sericite and biotite along loose and poorly developed parting planes, euhedral dodecahedral crystals, up to 1 3/4 and averaging 1 to 1 1/4 inches, moderate to highly pitted faces, 1 percent of crystals are less than 1/4 inch and are poorly formed and pink.

<u>Sample B</u>: Rock -- dark grey, very coarse-grained mica schist containing 45% garnet, 25% coarse-grained, green biotite, 5% black biotite; remainder quartz and feldspar with minor amphibole, muscovite and chlorite. The larger crystals and higher concentrations of garnet occur in zones containing abundant green biotite.

Garnet -- deep red, highly vitreous; a moderate coating of biotite and minor sericite on exposed faces; 3% inclusions of biotite, sericite, chlorite and quartz; subhedral crystals up to 2 1/2 inches and averaging 1 1/2 inches, faces moderately pitted.

<u>Sample C</u>: Rock -- grey, coarse-grained granite gneiss, 55% quartz and white feldspar, 25% garnet, 20% medium-grained biotite, rare kyanite.

Garnet -- light red, highly vitreous; thin coating of biotite, quartz and feldspar; 10% inclusions mainly of biotite; anhedral crystals up to 1 3/4 and averaging 1/2 and 3/4 inch, poor parting.

Sample D: Rock -- greenish grey, coarse-grained, biotite granite gneiss, 55% garnet, 25% granitic material, and 20% biotite and chlorite.

Garnet -- deep red, moderately vitreous, moderately granular, 50% of free faces coated with biotite and chlorite, 5% inclusions of mica and chlorite, subhedral with crystals up to 4 inches and averaging 2 inches in size, moderately irregular parting.

Sample E: Rock -- grey, coarse-grained, biotite granite gneiss, 50% quartz and white feldspar, 35% biotite with minor chlorite, and 15% garnet.

Garnet -- red, moderately vitreous, granular texture, coating of biotite, up to 50% inclusions, subhedral and anhedral crystals up to 3 1/2 inches and averaging 3/4 inch, low parting.

Sample F: Rock -- grey, coarse-grained, poorly gneissic biotite granite gneiss, 40% quartz and feldspar, 35% biotite, 25% garnet with rare kyanite and pyrite, larger garnets accompany the higher concentrations of biotite.

Garnet -- light red to lavender, granular texture, 10% inclusions subhedral crystals up to 1 3/4 inches and averaging 1/2 inch, poor, indistinct lamellae.

Sample G: Rock -- dark grey, medium to coarse-grained, quartz-biotite gneiss, 40% quartz and feldspar, 40% biotite and hornblende, and 20% garnet and rare kyanite.

Garnet-light red, to lavender, moderately glassy, scant inclusions; subhedral crystals less than 1/2 inch in size, 50% less than 1/4 inch; sparse and poor parting.

Microscopy

Most of the amphibole observed in sample A was identified by R. M. Buchanan as anthophyllite. Otherwise, the more detailed information accumulated during an examination of thin sections of the garnetiferous rocks added nothing of direct interest to this investigation.

Hardness

Garnet crystals from each sample were cut at right angles to the parting planes and polished. Each polished surface was tested for its relative hardness by means of a Jagger Scratch Hardness Tester. A new 7/8 inch Vulcarbo disc was used for each test. Testing was performed by grinding the polished surfaces in one direction for 500 revolutions and then in a direction at right angles to the first for a similar number of revolutions. The average lengths of the two grooves per sample were recorded and are listed below. The sample labelled 'Barton' was obtained from the quarry of Barton Mines Corporation at Gore Mountain, New York State, United States.

Sample	Average length of grooves per sample (in units)
A	31
B	31.5
C	32.5
D	33.5
E	29.5

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Sample	Average length of grooves per sample (in units)
F	36
G	Crystals too small for testing
Barton	30

CONCENTRATION OF SAMPLES

In order to determine the constituent heavy minerals, representative samples of each Sudbury sample were cleaned of magnetic minerals and concentrated by heavy liquid separation using acetic tetrabromide followed by methyl iodide. The heavy liquid concentrates consisted essentially of garnet with, in most cases, kyanite. Kyanite was not observed in the concentrate of sample A, was less than 1 percent in B, E, F and G, and was estimated to be 10 percent of concentrate C and 25 percent of concentrate D.

Garnet concentrates are produced at Barton mine by heavy media separation, jigging and flotation.

The eight samples were concentrated by the Milling Section using the procedure described in Mines Branch Investigation Report IR 58-98, by W. J. D. Stone. Each sample was crushed to minus 1 inch by a jaw crusher and then further reduced to minus 14 mesh by rolls. Fractions plus 20, 35, 65, 100, plus 150 and minus 150 mesh were separated by screening. Each fraction was passed once over a Whippet air table and the resulting concentrate repeatedly passed through a Dings magnetic separator until as clean a garnet concentrate as possible was produced. Because of the hornblende impurity and the small sized garnets in sample G, a suitable concentrate was not recovered. Suitable concentrates less than 150 mesh in size could not be produced by the air table.

Results of a microscopic examination of the minus 35 plus 65 mesh concentrates are given below. The sample CSP is a sample of garnet containing equal weights of garnet 35 to 48 mesh and 48 to 65 mesh in size. It was screened from garnet samples of 1 1/2 - 40, 1 - 50, and 1/2 - 60 grit that are currently being consumed by and were supplied by Canada Sand Papers Limited of Plattsville, Ontario. Because of the larger amount of the minus 35 plus 65 mesh concentrate and because it is the middle fraction, garnet concentrates of this size range were used for testing.

Sample	Colour	Lustre	Parting Planes	Inclusions (25X)	Estimated Impurities (%)
A	Lavender	low	none visible	rare	15-20(anthophyllit
B	Orange-red	moderate	low	rare	5-10
C	Lavender	low	faint	rare	1
D	Orange-red	moderate	minor	rare	2
E	Orange-red	moderate	minor	minor	4
F	Lavender	low	minor	minor	1-2
G	No suitable concentrate recovered				
RV	Orange-red	moderate	minor	rare	2
CSP	Orange-red	high	minor to low	none visible	2-3

In coarser fractions, all Sudbury samples contain more inclusions that the CSP sample.

Except for concentrate A, impurities consist mainly of biotite, pyrite and quartz. These Sudbury garnet concentrates have particle shapes similar to those of CSP garnet. Most particles are blocky with ragged, sharp edges. Less than 5 percent of the particles are shard-like. The only noticeable difference is that sample CSP is decidedly more vitreous and contains more orange colouring than the other samples. Concentrates of samples B and D appear to be more vitreous than other Sudbury samples possibly because of their darker colour. No kyanite was observed in the Sudbury concentrates but from 15 to 20 percent anthophyllite occurs in concentrate A.

TECHNOLOGY

Almandite, the most common variety of garnet, is the usual type consumed by industry. It is one of the hardest varieties of that mineral. Garnet is a 'high-grade' type of abrasive because of its physical properties and for technical abrasive purposes, should have the following properties: preferably a deep red to lavender colour, a hardness of over 7, a blocky particle shape with sharp edges, a relatively slow rate of breakdown during attrition, the ability to form new sharp edges when breaking down, and a high surface tension. On having these characteristics a garnet concentrate will have comparatively good abrasive qualities when coated on paper or cloth. Good surface tension properties are a basic necessity in order that the grains become completely coated with glue and adhere to the glue until they have become worn away.

TREATMENT AND TESTING OF GARNET CONCENTRATES

General

Because of its grain shape and parting, the Sudbury garnet would not be competitive for non-technical uses. As a result, this investigation is concerned only with the aspects involving technical uses. Garnet consumed for this purpose is further processed.

A method of heat-treating garnet concentrates in a furnace was developed and patented in 1931. It involves heating the garnet for from 3 to 16 hours at temperatures of 400 to 900°C. It is claimed that the process greatly improves the abrasive qualities.

Barton Mines Corporation heats garnet concentrates in a rotary drier followed by a rotary kiln primarily to remove adhering solutions resulting from wet concentration processes.

Processed concentrates are tested by colour comparisons, relative hardness, particle shape comparisons, surface tension properties, rate of breakdown during attrition, and effective abrasion. The deciding test is one which, when coated in a prescribed manner to the type of sized cloth or paper with the standard glue being used by the particular manufacturer in question, the garnet grains have a relatively low rate of breakdown and a highly abrasive effect. This test can be performed effectively only by the prospective manufacturer of the abrasive product. Because no standards are available, the results of all tests are compared with those involving the garnet being consumed.

Determination of Optimum Heating Conditions

In order to observe the effects of heat treatment on the Sudbury garnet concentrates it was necessary to determine the time - temperature relationship that would provide the best combination of abrasive requirements. As a result, 100 pounds of garnet crystals from the River Valley deposit were submitted by H. F. Wiemer for preliminary test purposes. These were crushed, sized and concentrated in a manner similar to that described in a preceding paragraph.

Initially, a sample of pure garnet from the Barton mine was tested in a Chevenard thermobalance to determine at what temperature a change might take place in specific gravity and possibly in other properties. On heating to 1832°F the specific gravity increased 0.32 percent. The region of maximum change occurred between the temperatures 1200 and 1300°F.

Differential thermal analysis of a pure sample of River Valley garnet indicates a slight endothermic reaction up to 1400°F followed by an abrupt exothermic reaction to 1580°F. A sample from the Barton mine produced a slight endothermic reaction up to 1256°F followed by a gradual exothermic reaction to 1630°F.

From the foregoing results it was decided to heat-treat a series of concentrates of the River Valley garnet for 1/2, 1 1/2 and 2 hours at temperatures of 1100, 1200, 1300, 1400 and 1500°F and to study the results. In each case, closely sized garnet minus 35 and plus 48 mesh, was placed in a cool Temco muffle electric furnace and the furnace was raised to the required temperature as quickly as possible and held there for the required length of time after which the sample was immediately withdrawn. The material was transferred to an oven at 195°F, kept in the oven a minimum of 12 hours, removed and allowed to cool for 1/2 hour, then tested for its surface tension properties. In each case the sample became more vitreous, darker in colour, and took on a more brownish metallic lustre with increasing time and temperature.

Relative capillarity, or surface tension measurements were performed by one technician who used the same apparatus in each case.

The apparatus consists of a glass tube approximately 8 inches long having an inside diameter of 6 mm and being closed at one end by a 65 mesh screen. The clean dry tube was partly filled with garnet grains, gently shaken down and immersed by its closed end in 15 mm of water. The rise of the water in centimeters, minus 15 mm is the relative capillarity for a given period. Measurements were taken at 1 1/2 and at 3 minutes. All tests were done in triplicate.

Capillarity tests were performed also on similarily sized natural or unheated River Valley garnet after the material had been in an oven at 90°C for more than 12 hours and allowed to cool at room temperature for 1/2 hour. Similar capillarity tests were made on garnet minus 35 and plus 48 mesh being consumed by Canada Sand Papers Limited at Plattesville, Ontario.

The numerous tables of results have been omitted for brevity and the results graphically presented in Figure 1. Results indicate that there is a general increase in surface tension properties with increased temperature of heat treatment and in most cases garnet treated for a half-hour period surpassed that treated for 1 and 1 1/2 hours. Up to and including 1300°F, the raw River Valley garnet was slightly inferior in capillarity to the heat-treated variety. The raw and heat-treated River Valley garnet had a noticeably greater capillarity than that received from Canada Sand Papers Limited.

The rate of breakdown of the raw and heat-treated samples was tested by the use of a N.V. Tema Vibratom attrition mill loaded

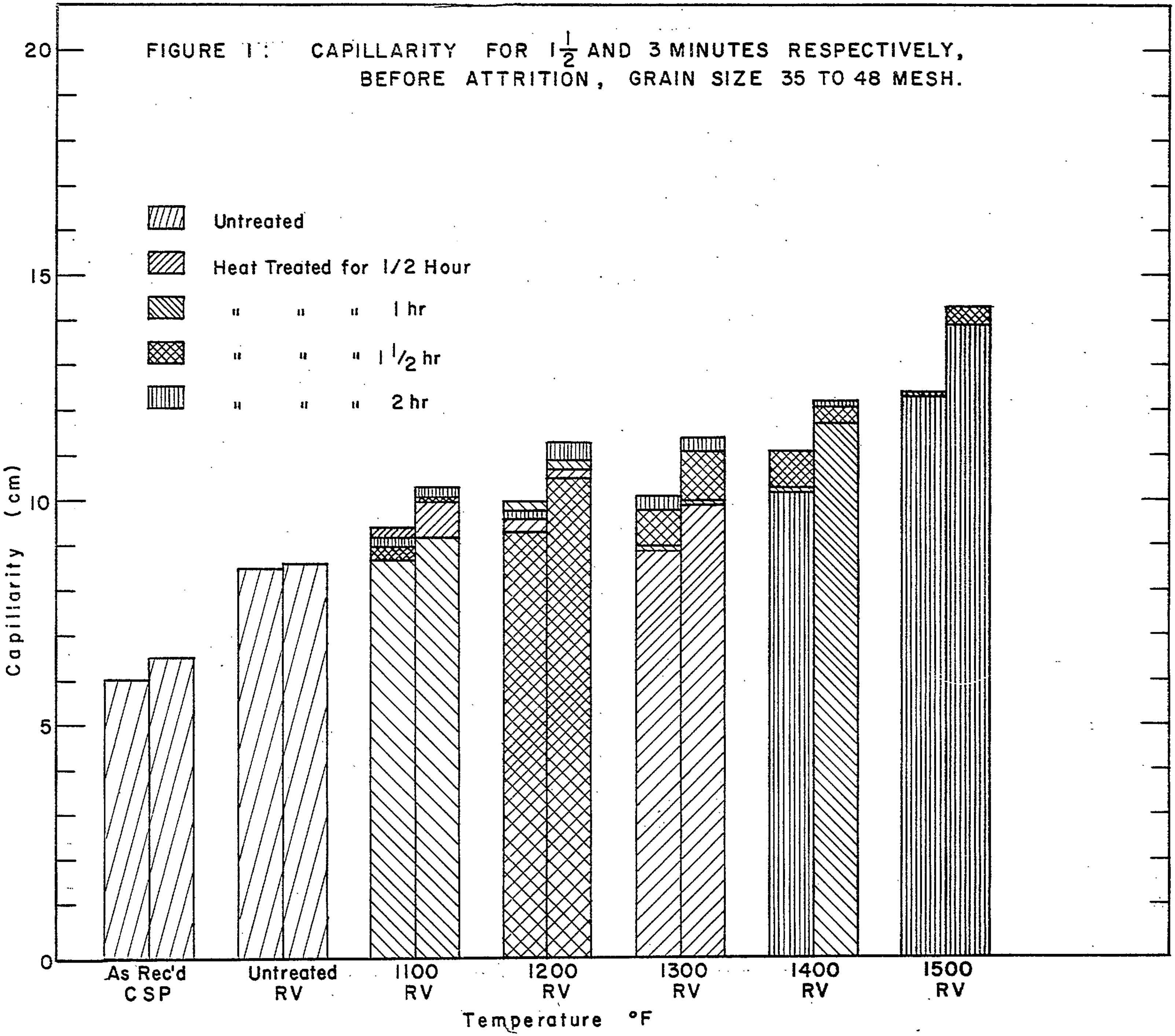
FIGURE 1: CAPILLARITY FOR 1 1/2 AND 3 MINUTES RESPECTIVELY, BEFORE ATTRITION, GRAIN SIZE 35 TO 48 MESH.
Untreated
Heat Treated for 1/2 Hour
" " " 1 hr
" " " 1 1/2 hr
" " " 2 hr
Capillarity (cm)
20
15
10
5
0
As Rec'd CSP
Untreated RV
1100 RV
1200 RV
1300 RV
1400 RV
1500 RV
Temperature °F

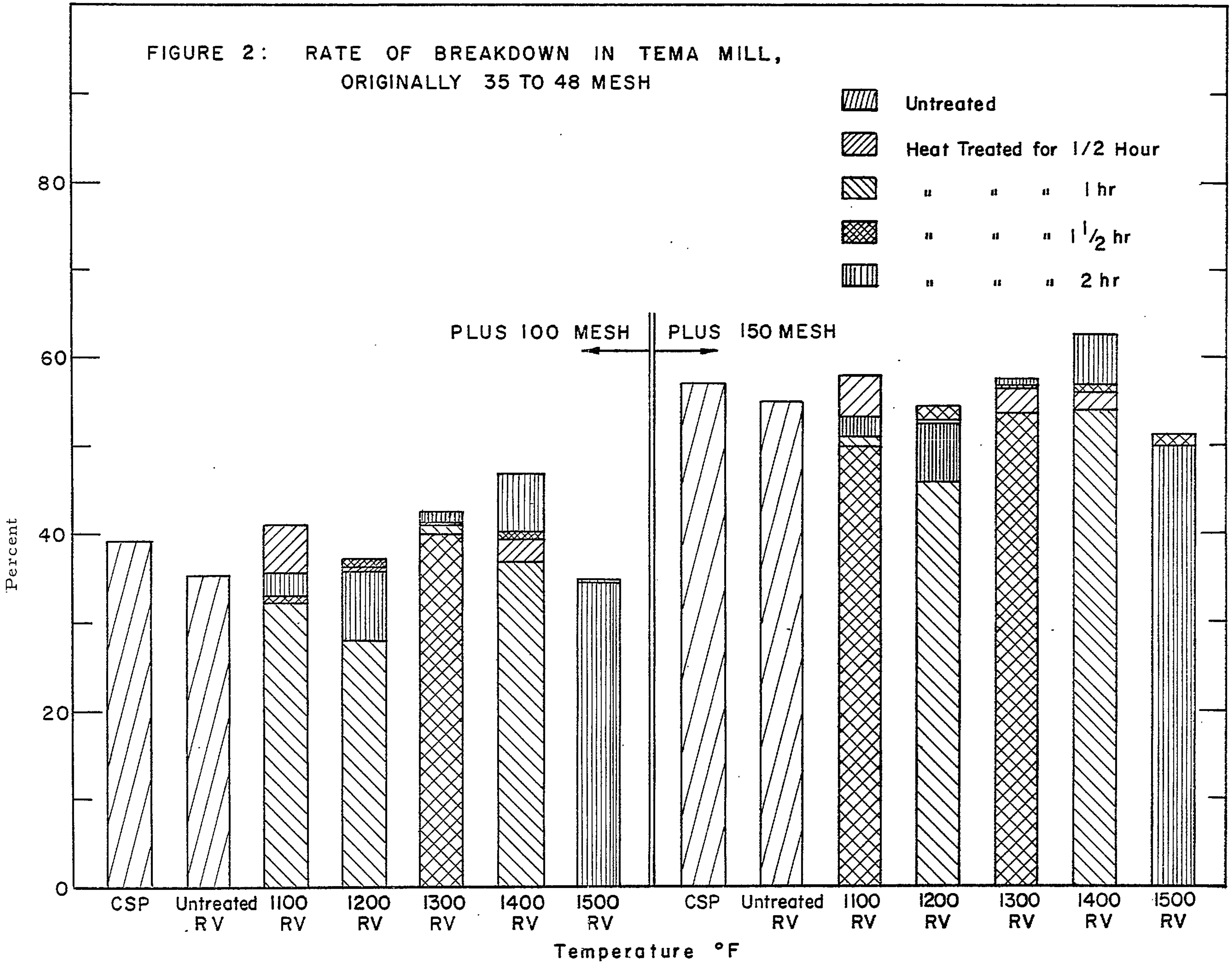

FIGURE 2: RATE OF BREAKDOWN IN TEMA MILL, ORIGINALLY 35 TO 48 MESH

with 500 grams of burundum balls and operated for 30 minutes. Sieve analyses were then made on the products and the results are shown graphically in Figure 2. These may be summarized as follows:

1. The results, indicated by plotting the percent of mineral plus 100 mesh in size, are proportional to those resulting from the use of 150 mesh as a basis.

2. Although garnet used by Canada Sand Papers Limited has slightly better breakdown qualities than the raw River Valley garnet, there is no appreciable difference between the results of that from sample CSP and the heat-treated River Valley garnet.

3. With the exception of garnet treated at 1400°F for 2 hours, the untreated River Valley garnet either breaks down in the Tema mill at a similar rate or in many cases at a slower rate than the treated variety.

4. Except for that treated at 1400°F, garnet treated for 1/2 hour gave results essentially as favourable as the other treated samples.

5. Except for the temperatures 1200 and 1500°F the heat-treated garnet has a slower rate of breakdown than that received from Canada Sand Papers Limited.

Conclusions

Although the raw River Valley garnet has better capillarity properties than that from Canada Sand Papers Limited, these properties generally increase with increasing temperature with the result that the best attained was at 1500°F over a period of 1 1/2 hours. The least amount of breakdown of all samples tested was attained from the River Valley sample heated at 1400°F for 2 hours. Favourable results were attained in both capillarity and breakdown from the River Valley sample heated at 1400°F for 1/2 hour.

TREATMENT AND TESTING OF SUDBURY GARNET CONCENTRATES

As a result of preliminary tests, sized concentrates of the Sudbury samples 14 to 20 and 35 to 65 mesh were tested for colour, grain characteristics, rate of breakdown and capillarity properties when in its natural state and when heat-treated at 1400°F for 1/2 hour and for 2 hours. Identical apparatus and procedures used for treating the preliminary RV sample were used for the Sudbury samples. Garnet minus 35 plus 65 mesh screened from samples received from Canada Sand Papers Limited was subjected to all similar tests with the exception of heat treatment.

Results of the microscopic examination may be summarized as follows:

Sample	Colour heated 1/2 hr	Colour heated 2 hrs.	Lustre
A	rusty brown	rusty brown	high
B	dark rusty brown	dark rusty brown	metallic
C	brown	brown	high
D	dark brown	dark brown	metallic
E	dark brown	dark brown	metallic
F	brown	brown	metallic

In general, the pink and red colour decreases with increased exposure to heat and the lustre of the garnet heated for 2 hours was very slightly higher. There was no apparent change in particle shape.

A portion of untreated sample D and portions treated at 1400°F for 1/2 hour and 2 hours were submitted for mineralogical examination. All were 35 to 65 mesh in grain size. R. M. Buchanan noted that X-ray diffraction analyses indicated no detectable difference between the three samples. However, refractive indices of the first two portions were identical ($1.7 < n < 1.80$) and the latter appeared to contain two types of garnet: a colourless mineral identical with that of the first two and a distinctly pink mineral having a higher index of $1.80 < n < 1.815$.

The results of the capillarity tests as represented in Figure 3 are as follows:

<u>14 to 20 mesh fraction</u>

1. The capillarity qualities of all untreated Sudbury samples are essentially the same except for sample A which had much better properties.

2. Upon heat treating for 2 hours at 1400°F the capillarity properties of all were improved, with those of A, B, C and D being somewhat similar, and those of E and F being decidedly less.

<u>35 to 65 mesh fraction</u>

1. The capillarity qualities of all untreated Sudbury samples are greater than those of the CSP sample with the exception of sample F which is essentially the same. Samples A and D have the highest values.

2. Capillarity properties of all samples were improved greatly

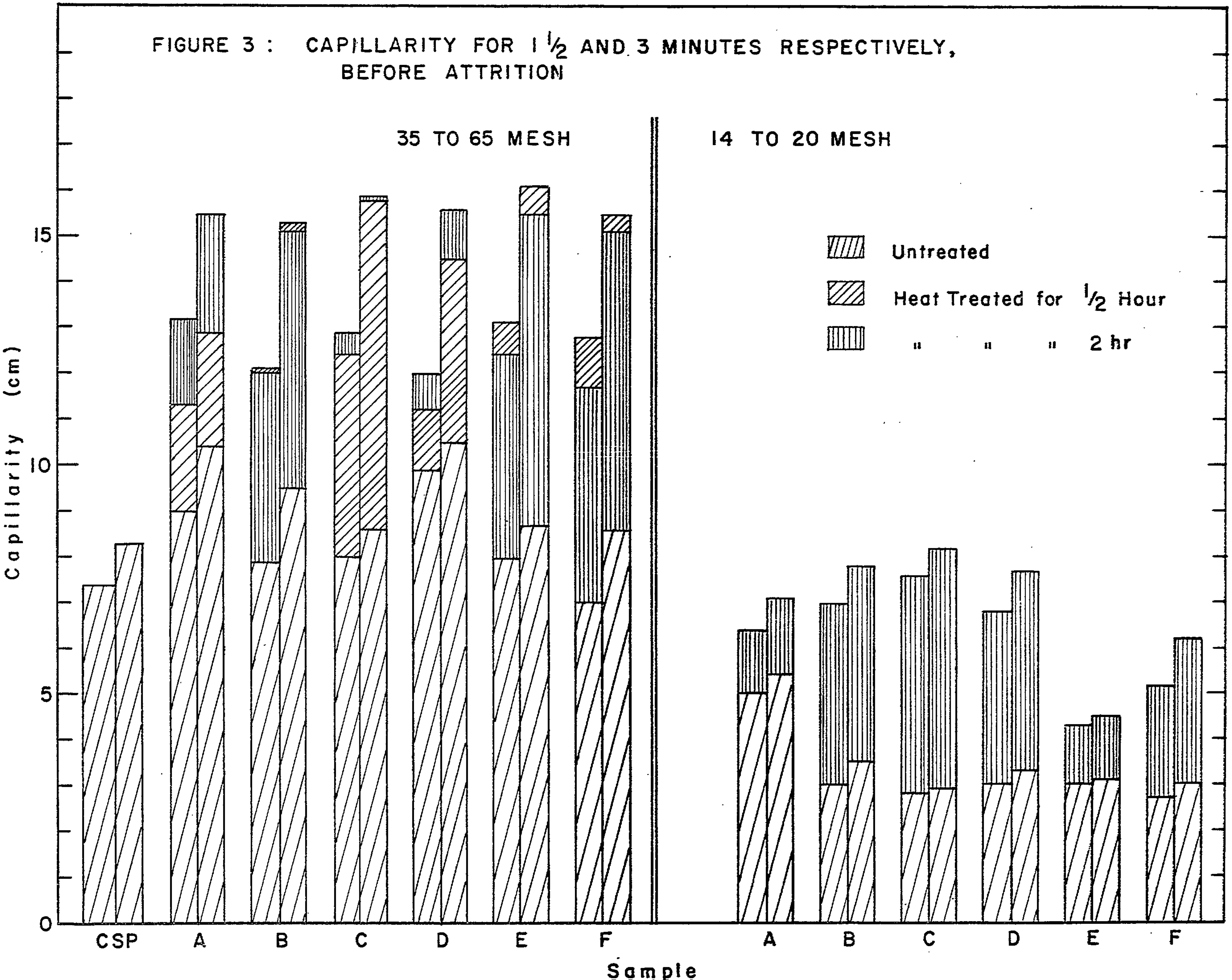
FIGURE 3 : CAPILLARITY FOR 1 1/2 AND 3 MINUTES RESPECTIVELY, BEFORE ATTRITION
35 TO 65 MESH
14 TO 20 MESH
Untreated
Heat Treated for 1/2 Hour
" " " 2 hr
Capillarity (cm)
0
5
10
15
CSP
A
B
C
D
E
F
A
B
C
D
E
F
Sample

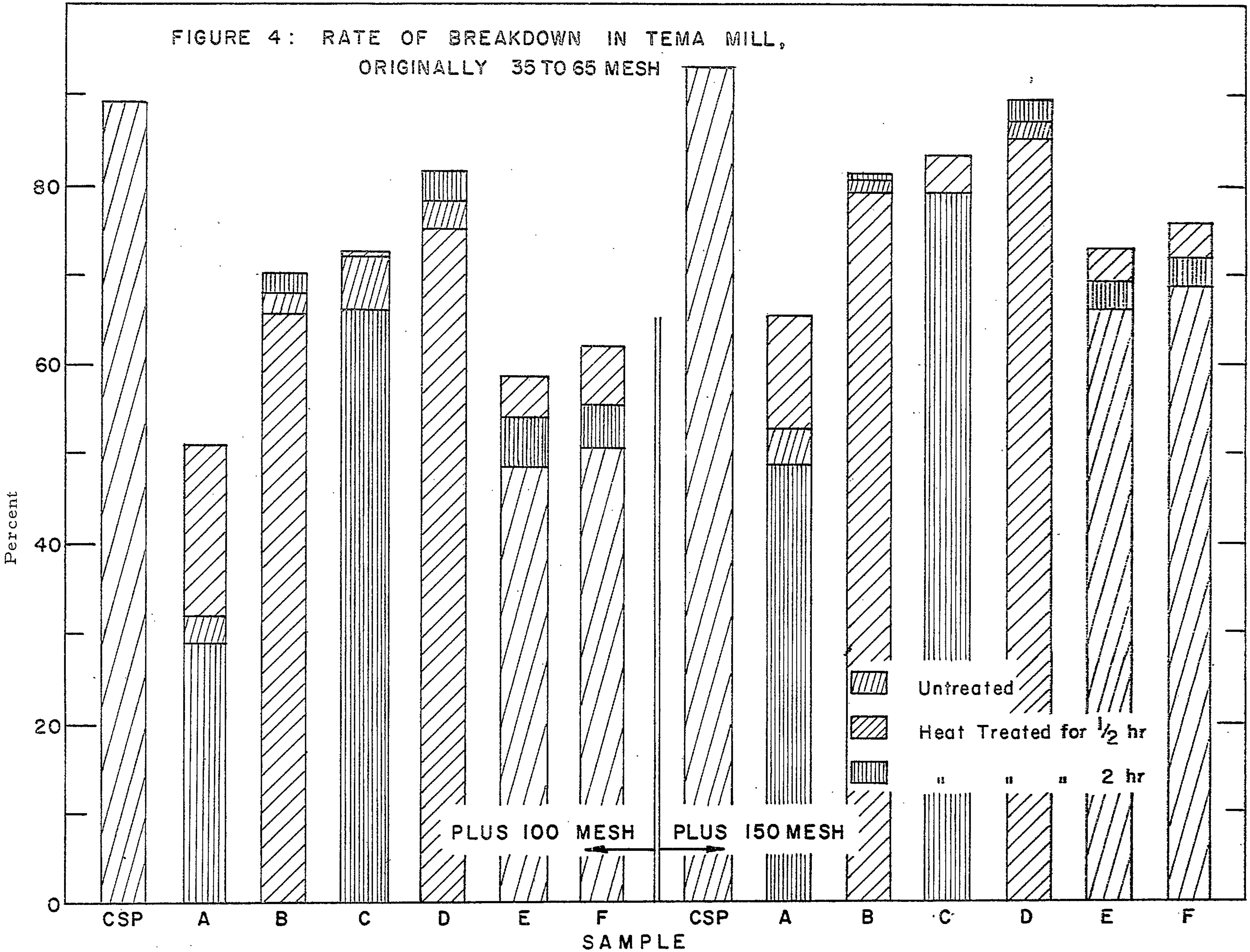

FIGURE 4: RATE OF BREAKDOWN IN TEMA MILL, ORIGINALLY 35 TO 65 MESH
Percent
0
20
40
60
80
CSP
A
B
C
D
E
F
SAMPLE
PLUS 100 MESH
PLUS 150 MESH
Untreated
Heat Treated for ½ hr
" " " 2 hr

by heat treatment and were improved more than 75 percent for sample E.

3. Heat treatment at 1400°F for 1/2 hour produced the best capillarity qualities with samples B, E and F and essentially similar qualities as the 2 hour treatment with samples C and D.

Results of tests to determine the relative rates of breakdown of the garnet samples are shown in Figure 4 and are summarized as follows:

<u>14 to 20 mesh fraction</u>

Results are inconclusive.

<u>35 to 65 mesh fraction</u>

1. The rate of breakdown of sample CSP is slower than that of the Sudbury samples with that of D most closely approaching it.

2. In 4 to 6 cases the untreated Sudbury garnet indicated a slower breakdown rate than the other Sudbury samples and in the case of samples B, C and D the raw variety was essentially as favourable as the heat-treated portions.

3. In general, heat treatment for 1/2 hour gave the best results.

DISCUSSION

The following comments refer to garnet for use as a technical abrasive.

The concentrates investigated have the same types and amount of impurities and grain size distribution as similarly sized concentrates would have from an operation consuming a Sudbury garnet ore and using the process developed by the Milling Section. As a result, and because all tests were performed by identical means, the foregoing results represent a means of comparing most of the properties required for an abrasive garnet with those of a garnet currently being consumed in Canada. The colour of the Sudbury treated garnet, although darker than the CSP garnet, is not greatly different when the grains are spread out as they would be in coated abrasives.

Particle shape characteristics of Sudbury and CSP samples appear to be similar under the microscope.

Garnet is consumed in fifteen grit sizes ranging from minus 14 to minus 325 mesh. The procedure developed by the Milling Section produces garnet concentrates from minus 14 to 150 mesh, a size range which would represent the coarsest nine grit sizes. Because of the limitations of the Whippet air table, another type of concentration, and probably a wet type, would be desirable to produce the remaining fine sizes. A complete size range of products would be necessary for a more successful operation. However, surface tension qualities will be affected by oils or additives used in certain wet processes and should be restored at least in part by heating to above 1000°F. As a result, the observations and conclusions concerning surface tensions of the Sudbury garnet submitted herein may not apply to concentrates produced by a wet process employing additives. Other physical properties of the garnet grains would remain unchanged.

Two important abrasive properties have not been compared: the abrasive effect and rate of breakdown of the coated sized garnet concentrates on various materials. These can be determined only by the individual manufacturers of coated abrasives. Such manufacturers employ various coating processes, different qualities of backing and various types of sizing and glue.

CONCLUSIONS

Garnet grains from the River Valley, Page and MacDonald garnet deposits of the Sudbury area in the 35 mesh to 65 mesh size range, which had been concentrated mainly by means of a Whippet air table, were compared with the imported garnet being used by a leading Canadian manufacturer of coated abrasives. The Sudbury garnet has similar particle shapes, slightly darker colour, up to 35 percent better capillarity properties and a rate of breakdown that is from 9.3 percent to 53.8 percent greater. Of the natural Sudbury samples tested, sample D from the central zone of the River Valley deposit has the best of the tested properties for abrasive uses. In the case of sample D, heat treatment at 1400°F for 1/2 hour increases the relative capillarity to 51 percent more than that of the CSP garnet. However, it also increases the relative rate of breakdown to an average of 12 percent greater than that of the CSP garnet but still produces a garnet having a lower breakdown rate than that of the other Sudbury samples.

Whether the better capillarity qualities of the natural and heat-treated Sudbury garnet will compensate for its relatively greater rate of breakdown in actual practice is a problem for an individual abrasive manufacturer. The manufacturer could produce coated abrasives from these grains and test the abrasive quality using his standard methods. Similarly, the economics of heat-treatment at 1400°F for 1/2 hour can be determined only by the manufacturer. Samples of natural garnet and a sample of that heat-treated at 1400°F for 1/2 hour taken from the location of sample D, could be investigated.

The foregoing conclusions apply only to concentrates recovered by a dry milling process or a wet milling process employing no additives. After heat treatment, concentrates resulting from a wet milling process employing an additive would have similar properties as the above except for possible lower capillarity qualities.

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