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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

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Ottawa, January 27, 1947.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2169.

Investigation of Two Pieces of Cyanided Steel Engraving Plate.

(Copy No. 5.)

CANADA

Bureau of Mines

Mineral Dressing and
Metallurgy Division

DEPARTMENT
OF
MINES AND RESOURCES

Physical Metallurgy
Research Laboratories

Mines and Geology Branch

O T T A W A

January 27, 1947.

R E P O R T

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ORE DRESSING AND METALLURGICAL LABORATORIES.

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Origin of Material and Object of Investigation:

On January 17, 1947, Mr. R. P. White, of the British American Bank Note Company Limited, Ottawa, Ontario, submitted two pieces of cyanided plate to these Laboratories for examination. In the accompanying letter, Mr. White stated that:

> "one of our large plates (24 x 28) had been very difficult to harden and when this was finally accomplished it wrinkled and cracked while being bent.
>
> "Tabulated below for your information are the readings that were taken each time the plate was

(Origin of Material and Object of Investigation, cont'd) -

immersed in the cyanide bath:

Date	Time in Bath	Temperature	% KCN	Scleroscope
Dec. 4	22 minutes	1540° F.	44.7	32-39
" 4	22 "	1550° F.	44.7	32-40
" 4	26 "	1580° F.	44.7	33-40
Jan. 6	25 "	1540° F.	90.4	38-43

Between the 4th December and the 6th January a new pot with new cyanide was put in the furnace. The percentage of KCN varies considerably but at the same time it should be remembered that on each of these occasions other plates were hardened under identical conditions and came out quite satisfactorily.

"By hand with this letter are going two pieces of steel, one marked 1 on the back, cut from the top and the other, marked 2, cut from the bottom of this plate. You will note that #1 is cracked and #2 is wrinkled."

EXPERIMENTAL

Chemical Analysis:

Drillings were taken, for chemical analysis, from each piece of steel after the top cyanided layer had been removed by grinding. The results were:

	Sample No. 1	Sample No. 2.
	(Per Cent)	
Carbon -	0.26	0.33
Manganese -	0.28	0.28

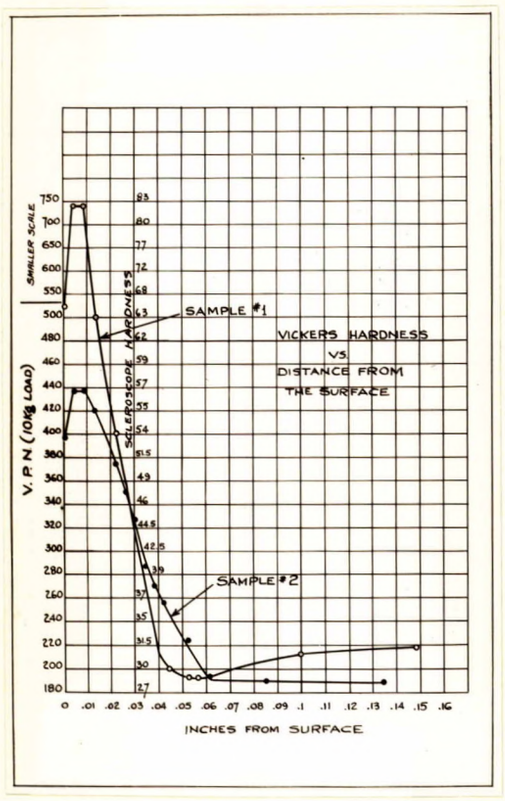
Hardness Tests:

Microspecimens were cut from each piece of plate. These were mounted in bakelite and hardness readings were taken across the face so that a complete hardness survey was obtained from the centre to the surface of each piece. The Tukon Knoop hardness numbers were translated to Vickers and Scleroscope readings. These are plotted on the chart shown in Figure 1.

(Continued on next page)

(Hardness Tests, cont'd) -

Figure 1.



VICKERS HARDNESS VS. DISTANCE FROM SURFACE.

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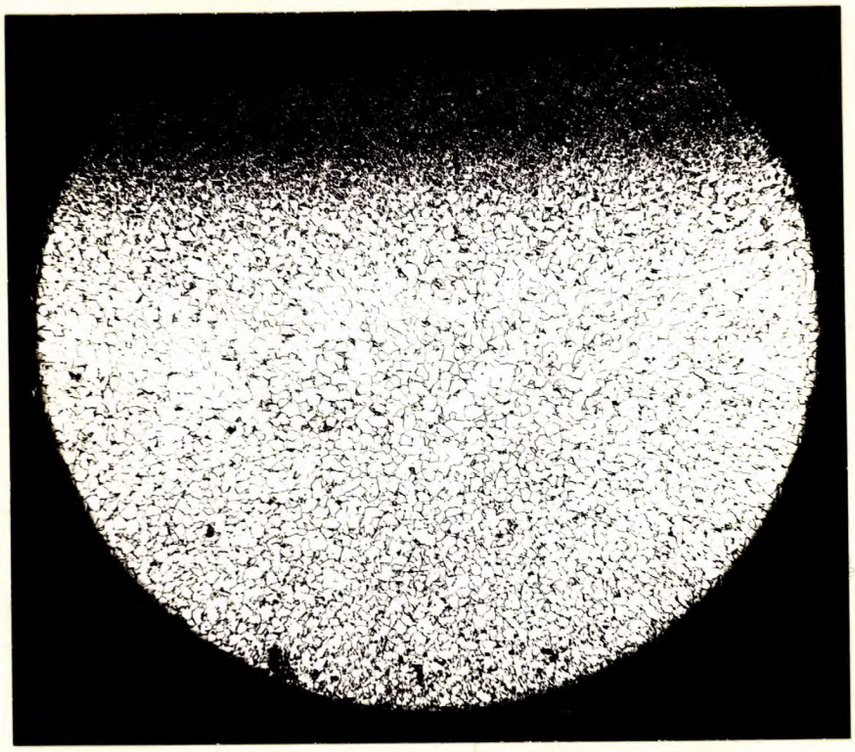
Microscopic Examination:

Microspecimens were cut from each sample. These were polished, etched in 2 per cent nital, and examined under the microscope. Figure 2 (X100) illustrates the 0.007 inch (approx.) depth of case obtained for Specimen No. 1. Immediately below the case, an extensive low-carbon area is observed. Figure 3 (X100) is a photomicrograph taken of Specimen No. 2. A much shallower case was obtained on this part of the plate (0.002 to 0.003 inch).

(Figures 2 and 3 follow,
on Page 4.)

(Microscopic Examination, cont'd) -

Figure 2.



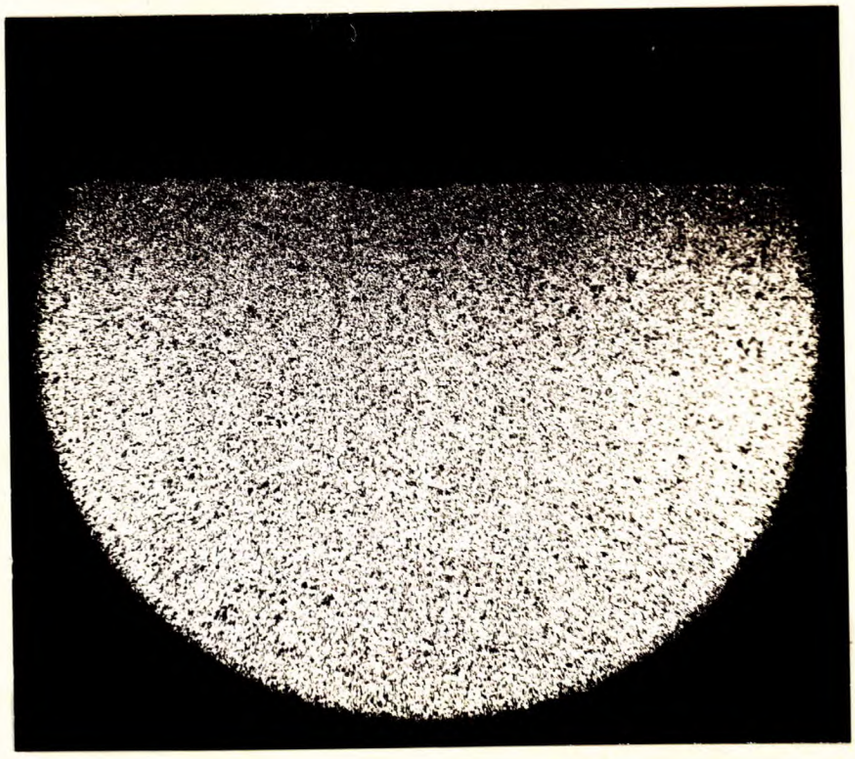
X100, nital etch.

SAMPLE NO. 1.

0.007 inch (approx.) case depth.

-

Figure 3.



X100, nital etch.

SAMPLE NO. 2.

0.002 to 0.003 inch case depth.

Discussion:

The chemical analysis indicates a variation in carbon content of the plate. The photomicrographs also verify this, since more pearlite is present per unit area in Figure 3 of Sample No. 2 than is shown by Figure 2 of Sample No. 1. This difference in carbon content is probably due to unequal decarburization of the original plate. Figure 2 indicates that the decarburization has considerable depth at the top of the plate.

If a thin case is obtained, hardness readings taken on the surface may be low due to the case not being sufficiently supported by the low carbon, low strength backing material. By repeated cyaniding treatments the case depth and hardness were increased to a point where the case itself was able to take the major portion of the hardness testing load.

The case depth of 0.007 inch having a hardness of roughly 82 Scleroscope 0.004 inch below the surface is too thick and too hard to withstand the bending stress without cracking. As a control test it would be advisable to have extra metal at one side of the plate which could be removed and examined by microscope should any irregularities occur in the heat treatment of the plate. If a plate does not give proper results after the first hardening treatment, a specimen could be cut from it and examined to determine whether or not the case depth is sufficient for the subsequent operations and/or whether decarburization is obscuring the proper hardness of the surface, etc.

Conclusions:

1. The carbon contents of the two specimens submitted vary.

2. The plate is badly decarburized at the top;

(Continued on next page)

(Conclusions, cont'd) -

this would account for the lower carbon content of Sample No. 1.

3. The decarburized area accounts for the low hardness readings obtained on the first cyanide treatment.

4. A case of 0.007 inch depth, approximately, was obtained on Sample No. 1 whereas one of 0.002 to 0.003 inch was obtained for Sample No. 2.

5. Although translated hardnesses (Knoop to Scleroscope) are not as accurate as actual tests by the Scleroscope machine, it is nevertheless evident that a considerably higher hardness was obtained on Sample No. 1 than on Sample No. 2.

6. The plate cracked at the point where Sample No. 1 was taken, due to the case being too thick and too hard.

Recommendation:

If possible, extra metal should be left on the plate when it is cyanided. Should irregularities occur, a microscopic check could then be made to determine what action to take.

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