O T T A W A July 21st, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1054.

(Appendix to Investigation No. 1043).

Examination of Armour Plate Samples.

BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
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CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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Origin of Material and Object of Examination:

On July 9th, 1941, three samples of armour plate were received from Major J. L. McAvity, of the Department of National Defence (Army), Ottawa, Ontario. An accompanying letter (File No. H.Q. 46-1-73, Vol. 3, H.Q. C.8822, D.T.R.) asked that the plates be examined in order to determine whether they would be a satisfactory material for steel helmets. It also stated that the plates were sent in by Mr. L. V. Sullivan, of Hamilton, Ontario, and that the steel was similar to that in plates dealt with in our Investigation No. 1043 (July, 1941).

Nature of Samples:

Two samples, Plates 1 and 2, were of circular shape and flat. The other sample, Plate 3, was semicircular and bent. The average thickness of Plate 3 was 0.042 inch. Both circular plates were 0.041 inch thick.

Hardness Tests:

Hardness tests were made, using the Vickers method and a 50-kilogram load. The following table lists the results obtained:

	Average hardness, V.P.M.	Hardness range, V.P.M.	Equivalent average Brinell hardness
Plate 1	242	227 - 270	242
Plate 2	246	241 - 248	246
Plate 3	499	486 - 514	465

Chemical Analysis:

Drillings taken from Plates 1 and 2 were found to have the following composition:

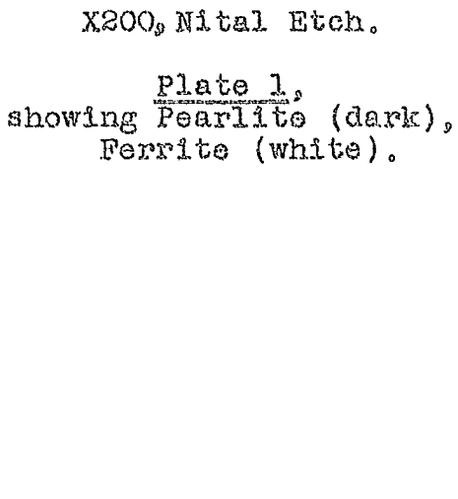
Carbon, per cent	Manganese, per cent	Silicon, per cent	Sulphur, per cent	Phosphorus, per cent	Chromium, per cent	Nickel, per cent	Molybdenum, per cent
0.62	0.77	0.20	0.019	0.016	Nil	Nil	Nil

Microscopic Examination:

The steels contained about the same number of non-metallic inclusions as are shown in Figures 1 to 3 of Investigation No. 1043. The structures of the plates, as revealed by a nital etch, are shown in Figures 1 to 3.

(Figures 1 to 3 follow on next page)

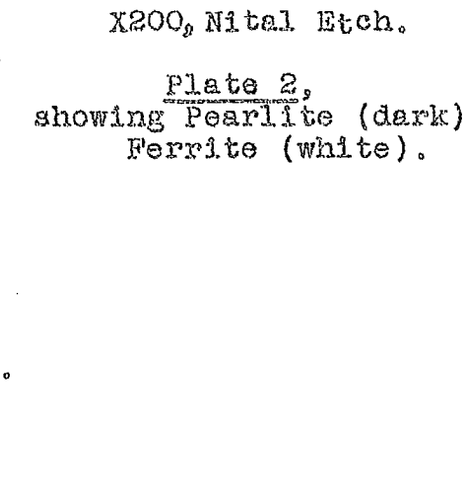
Figure 1.



X200, Nital Etch.

Plate 1,
showing Pearlite (dark),
Ferrite (white).

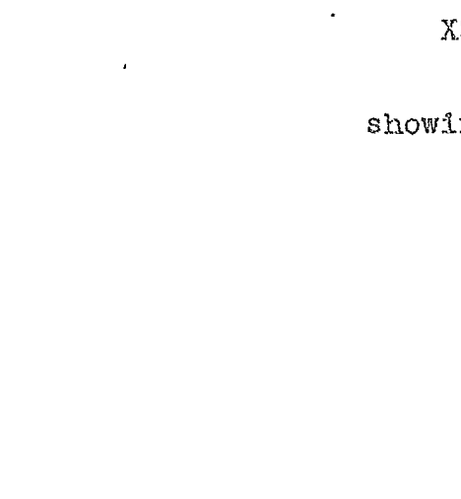
Figure 2.



X200, Nital Etch.

Plate 2,
showing Pearlite (dark),
Ferrite (white).

Figure 3.



X200, Nital Etch.

Plate 3,
showing Heat Treated
Structure.

Discussion of Results:

Manganese steel hats that had been submitted for examination in connection with another investigation were found to be 0.040 inch thick. It is assumed, then, that the sheet under examination is of the correct thickness and would not require re-rolling if made into hats.

Hardness tests show that only Plate 3 was in the hardened condition. This latter plate has about the optimum hardness for armour plate material.

There is nothing unusual in the steel composition, which comes within the requirements of S.A.E. Steel 1050. The manufacture of such a plain carbon steel involves no great difficulties. The steel is of the same type as that reported on in Investigation No. 1043.

The cleanliness of the steel indicates good steel-making practice. The inclusions present should not impair the resistance of the material to projectiles as they are not elongated. The microscopic examination confirms the results of hardness testing in that it shows that Plates 1 and 2 are in the annealed condition, while Plate 3 has been given a hardening treatment. The grain structure of the latter plate is too fine to indicate whether it had been given the "quench and draw" or the austempered heat treatment. If the high-carbon steel at 465 Brinell does not crack under projectile impact the probability is that it has been austempered. The microscopic examination also shows that one surface of Plate 1 had been slightly decarburized. This accounts for the greater spread in the hardness test results obtained for this sheet. The fact that only one surface of this plate was decarburized and that Plate 2 was free from decarburization indicates that the plates had been annealed in packs.

(Concluded on next page)

Conclusions:

The three plates are of the same material as in plates reported on in Investigation No. 1043. The plates are of the proper thickness for steel helmets. Only ballistic tests would show whether steel helmets made from this steel would give suitable protection, but it is considered likely that good results would be obtained if the steel were used in the austempered condition. The hats would differ from the hat now being used in that they would be magnetic. It is not known whether or not this is objectionable, but it is thought that the hat of a soldier working gun-laying equipment, etc., should not be magnetic. However, it has been reported that the respirator cannister is magnetic and affects a compass. If magnetic material is allowed in this part it probably could be allowed in a hat.

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