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EXAMINATION OF METAL RELICS FOUND ON MEIGHEN ISLAND, N. W. T.

by

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SUMMARY OF RESULTS

Two corroded tin-plate containers from one camp site, date unknown, and a third can from beside a cairn of known date were submitted by the Geographical Branch, Department of Mines and Technical Surveys to the Physical Metallurgy Division for metallurgical examination of the tin-plate in an attempt to establish the probable date of manufacture of the containers.

The steel used in the unknown containers was identified as of acid Bessemer grade. The basis steel sheet apparently was manufactured by the hot pack-rolling method followed by hot-dip application of a thick coating of tin in the presence of zinc chloride flux.

Use of zinc chloride flux indicated that the tin-plate had been manufactured since 1910 and suggested that the containers were more probably left by Stefansson in 1916 or by Dr. Krueger in 1930 than by Dr. Cook in 1908.

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INTRODUCTION

The severely corroded remains of a large tin-plated container and two small tin cans were submitted to the Physical Metallurgy Division, Mines Branch, Department of Mines and Technical Surveys by Mr. K.C. Arnold of the Geographical Branch, for metallurgical examination and for any possible assistance in establishing the age of these articles.

A covering letter stated:

"During a glaciological field season spent on Meighen Island in the summer of 1962, Mr. K.C. Arnold of the Geographical Branch discovered some old cans near the coast of Meighen Island, (Figure 1).

The historical background of the discovery of this island is still controversial and is linked with Dr. F.A. Cook's claim to have reached the North Pole in 1908, a year before Peary. This claim is generally rejected. Cook always denied having visited Meighen Island, although the statements made to Peary by his Eskimo companions indicate that he did indeed visit the island.

I wonder if members of your Branch might have knowledge of techniques that might indicate the age of these cans. If it can be shown that they date before 1910, it is more likely that they are Cook's. Stefansson was not carrying canned food at the time that he made his discovery of Meighen Island in 1916". Dr. Krueger's visit occurred in 1930.

Figures 1 and 2 illustrate the remains of the large container (pemmican can) found by Mr. Arnold on the shore of Meighen Island about 3 miles north of Stefansson's discovery cairn at Anderson point. The small rectangular-shaped can ("cocoa" tin) found beside the discovery cairn is also shown in Figure 2. The third sample, a small round can found with the pemmican can is illustrated in Figure 3 (two views). Distinctive manufacturing features of the cover-hole and soldered body seam were still well preserved on this third can and it was suggested that major can manufacturers should be solicited for assistance in establishing its identity. In this connection, Mr. Arnold's letter to the Continental Can Company is included below for reference purposes. Viz:

"In the summers of 1959 to 1962 I was studying the small ice cap on Meighen Island, N.W.T. (80°N, 100°W). The history of the discovery of this island is controversial. Ellef Ringnes Island to the southwest, Amund Ringnes Island to the south and Axel Heiberg Island to the east were discovered by the Second Norwegian Arctic Expedition in the "Fram" (1898 to 1902), but they failed to chart Meighen Island on their maps.

Vilhjalmur Stefansson became the official discoverer of Meighen Island when he landed on its southwest corner, June 15, 1916, and raised a cairn to commemorate his discovery. Eight years before, however, Dr. F.A. Cook had claimed to have reached the North Pole one year before R.E. Peary's generally accepted claim was made. On his return journey the drift of the polar ice took Cook to the west of his outward journey, and he should have passed very close to Meighen Island. However, he makes no report of having seen it. Peary when he learned of Cook's claim to the Pole, was able to interrogate the Eskimoes who had travelled with Cook. They gave a story which suggested that Cook had indeed discovered Meighen Island in 1908.

In 1937, by chance, Stefansson's attention was drawn to a map published in 1909 supporting the Peary claims that showed Meighen Island in substantially correct position, size and height - this seven years in advance of Stefansson's generally recognized discovery.

During the summer of 1962 I was engaged in examining the ice-free areas of the island as well as the ice cap itself. While walking along the west coast of the island I found two cans, the photograph of one of which (Figure 3) is enclosed. This can appears to have been a meat can, tobacco can, or condensed milk can, and it appears quite old as the thick soldered seam on the side of it is not characteristic of later cans. I can be quite sure it is not a relic of any recent visitor to the island. The other can was a dog pemmican can made of folded thin sheet metal and hand-soldered at the seams but it was not as well preserved as the other one, although it is still available for inspection if this should be useful.

I am wondering whether there might have been any rapid advances in the technology of can making just after the turn of the century, that might be of use in putting a date to this find. I feel that it could either date from 1908 in which case it would be Cook's, from 1916 in which case it would be Stefansson's, or from 1930 in which case it could have been left by H.K.E. Krueger, who disappeared in the vicinity of Meighen Island in 1930, and whose last record was found in 1957 about 3 miles south of where this can (Figure 3) was found. I feel that it is unlikely that the can was left by Stefansson as his accounts (The Friendly Arctic, Chapter LI, p. 521) suggest that they had exhausted their canned supplies at that time and were living on eggs and game".

HISTORICAL SEQUENCE OF VISITS TO MEIGHEN ISLAND

1908 - Dr. F.A. Cook (?). Alleged by Peary to have visited the island. Account based on testimony of two Eskimoes who travelled with Cook.
(Largely substantiated by Stefansson in "The Problem of

Meighen Island.")
Cook denied seeing the island.

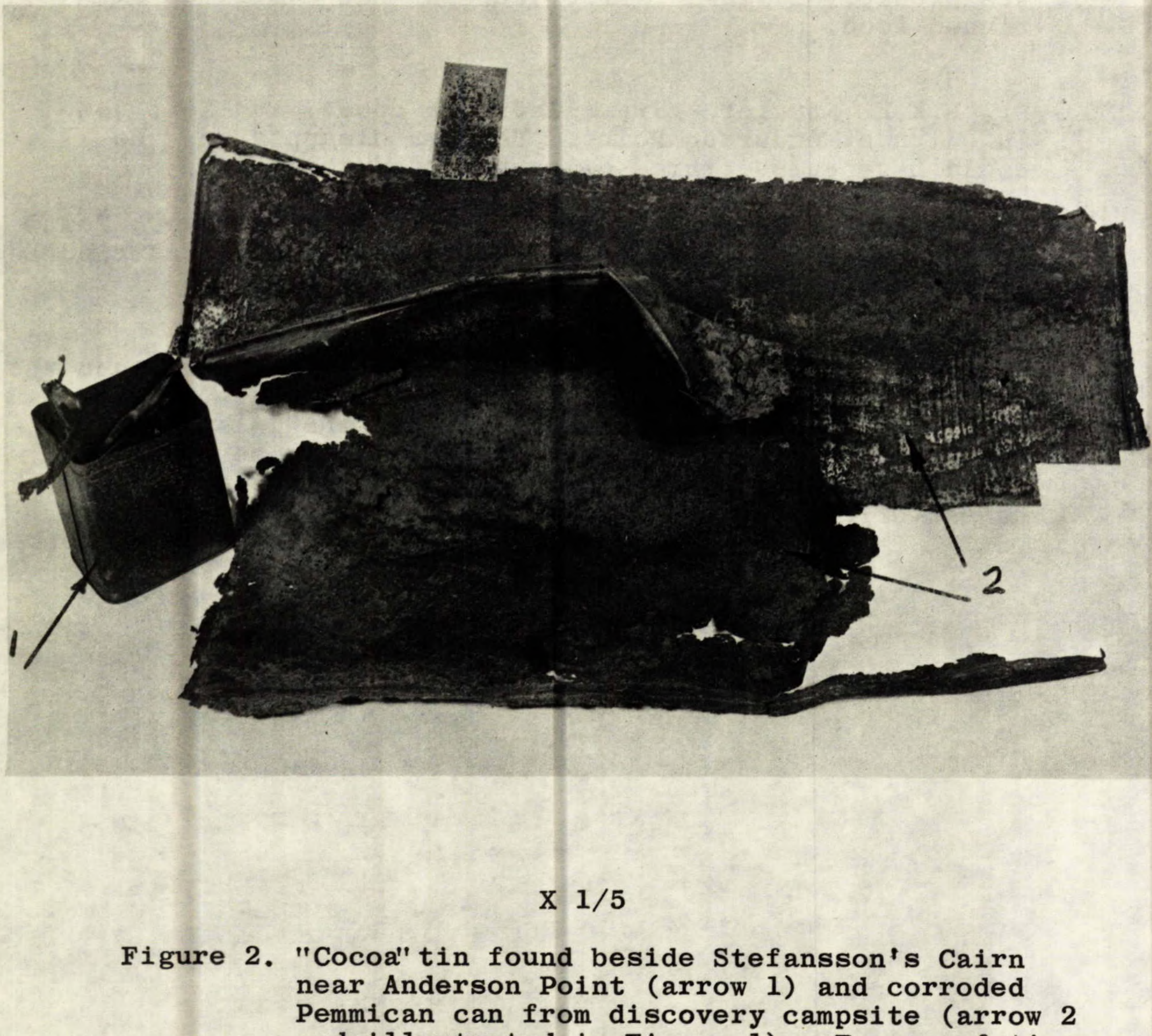
1916 - Stefansson - "Official discovery". At this time Stefansson was probably living off the land and had a minimum of tinned food.

1930 - Dr. H.K.E. Krueger - Travelled down coast, and left note in cairn at Anderson Point. He then disappeared. He could have camped three miles north of the point.

1957 - Dr. R. Thorsteinsson (Geological Survey of Canada). Found Krueger's last note. The relics found cannot be attributed to Thorsteinsson.

1960, 1961, 1962 - Polar Continental Shelf Project Visits. (According to Mr. Arnold, if the large pemmican can and the small round can found in 1962 are shown to date before 1930, the probability is enhanced that the island was visited by Cook in spite of his denials. Some of his pictures resemble Meighen Island, and his account of what he saw off its coast is not consistent with the facts.)

Figure 1. Discovery of Pemmican Can and Campsite, Meighen Island, 1962 - K.C. Arnold. Geographical Branch.

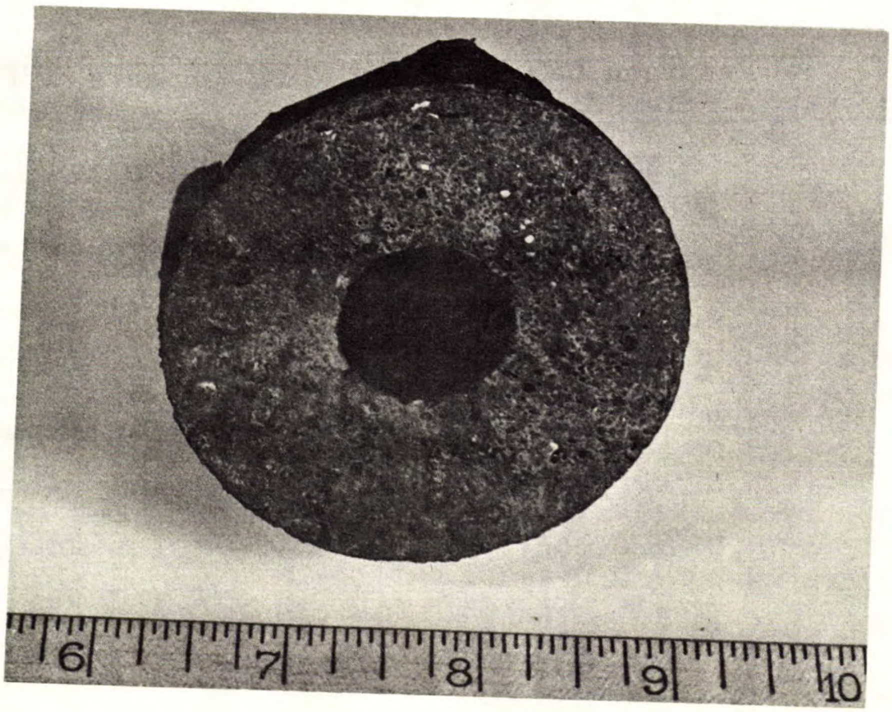


X 1/5

Figure 2. "Cocoa" tin found beside Stefansson's Cairn near Anderson Point (arrow 1) and corroded Pemmican can from discovery campsite (arrow 2 and illustrated in Figure 1). Traces of tin coating are still visible on the pemmican can and also on the inside surface of the small "cocoa" tin.

- actual size -

(a) Side View - Round can from campsite showing distinctive machine-soldered seam.



(b) Top View

Figure 3. Round can with central hole at top side. Corrosion has caused perforation and severe wastage of tin-plate and basis steel.

EXAMINATION OF SAMPLES

Metallurgical examination of the pemmican can and "cocoa" tin (Figure 2) were carried out as follows:- (The round can, shown in Figure 3, was retained by the Geographical Branch).

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(1) Chemical and quantitative spectrographic analyses on basis steel from the cans illustrated in Figure 2.

(2) Metallographic examination of basis steel on samples shown in Figure 2.

(3) Metallographic examination of solder and tin coating on pemmican can (Figure 2) and chemical composition of solder.

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(1) Chemical and Quantitative Spectrographic Analysis of Basis Steel

TABLE 1

Chemical Composition (Per Cent)

Element	Pemmican Can (Fig. 2)	"Cocoa" Tin (Fig. 2)	Modern Tin-Plate (MC-T6)
Carbon	0.13	0.06	0.12 max.
Manganese	0.42	0.44	0.20/0.60
Silicon	Tr.	0.01	0.01 max.
Sulphur	0.091	0.071	0.05 max.
Phosphorus	0.13	0.094	0.10/0.15
Nitrogen	0.011	0.008	
*Aluminum	0.003		
*Copper	0.14		0.020 max.
*Nickel	N.D. (<0.026)		**0.040 max.
*Chromium	N.D. (<0.078)		**0.060 max.
*Molybdenum	N.D. (<0.005)		**0.050 max.
*Zirconium	Nil		
*Titanium	N.D. (<0.004)		
*Tin	N.D. (<0.001)		
*Antimony	Nil		
*Vanadium	N.D. (<0.002)		
*Zinc	Nil		
*Cobalt	N.D. (<0.026)		
*Arsenic			**0.020 max.
All Others Total			**0.020

*quantitative spectrographic analysis. **maximum residual content in modern specification MC-T6. N.D. - not detected to values shown. Tr. - Trace.

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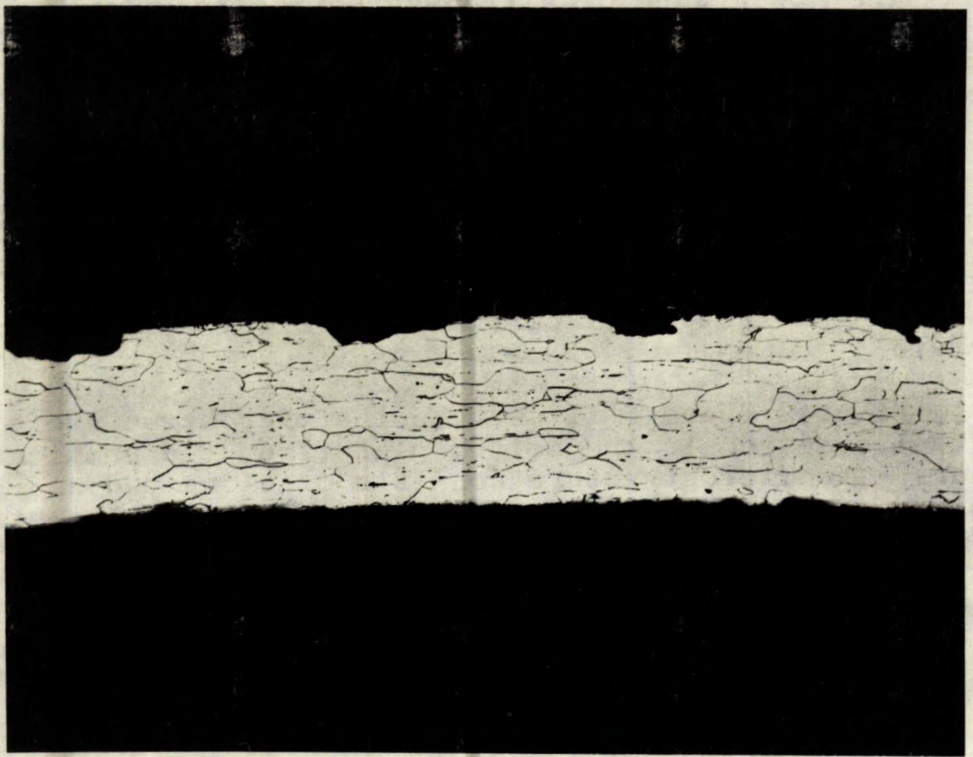
The basis steel is identified as of rimming grade and acid Bessemer manufacture.

(2) Metallographic Examination of Basis Steel (Samples, Figure 2)

The appearance of a transverse section through the "cocoa" can (arrow 1, Figure 2) is illustrated in Figures 4 and 5. The microstructure consists of ferrite with small quantities of massive, grain-boundary, cementite. Subcritical grain growth has occurred and the ferrite grains are elongated.

This microstructure was possibly produced by hot pack-rolling accompanied by slow cooling of packs at temperatures below 732°C (1350°F). The composition of the steel with respect to silicon, phosphorous, sulphur and nitrogen, indicates that this can was manufactured from rimmed steel of acid Bessemer manufacture.

Figures 6 and 7 illustrate the microstructure of the basis steel observed in the bottom plate from the pemmican container. The microstructure consists of elongated and coarse ferrite grains and bands of spheroidized carbide. The structure is considered representative of rimmed, acid Bessemer steel in the hot, pack-rolled condition where banded pearlite areas have spheroidized during cooling of the pack. This microstructure and composition would have been more common in tin-plate of 1900 to 1935 vintage, although small quantities of this material were produced as late as 1940.



X100 etched 2% nital

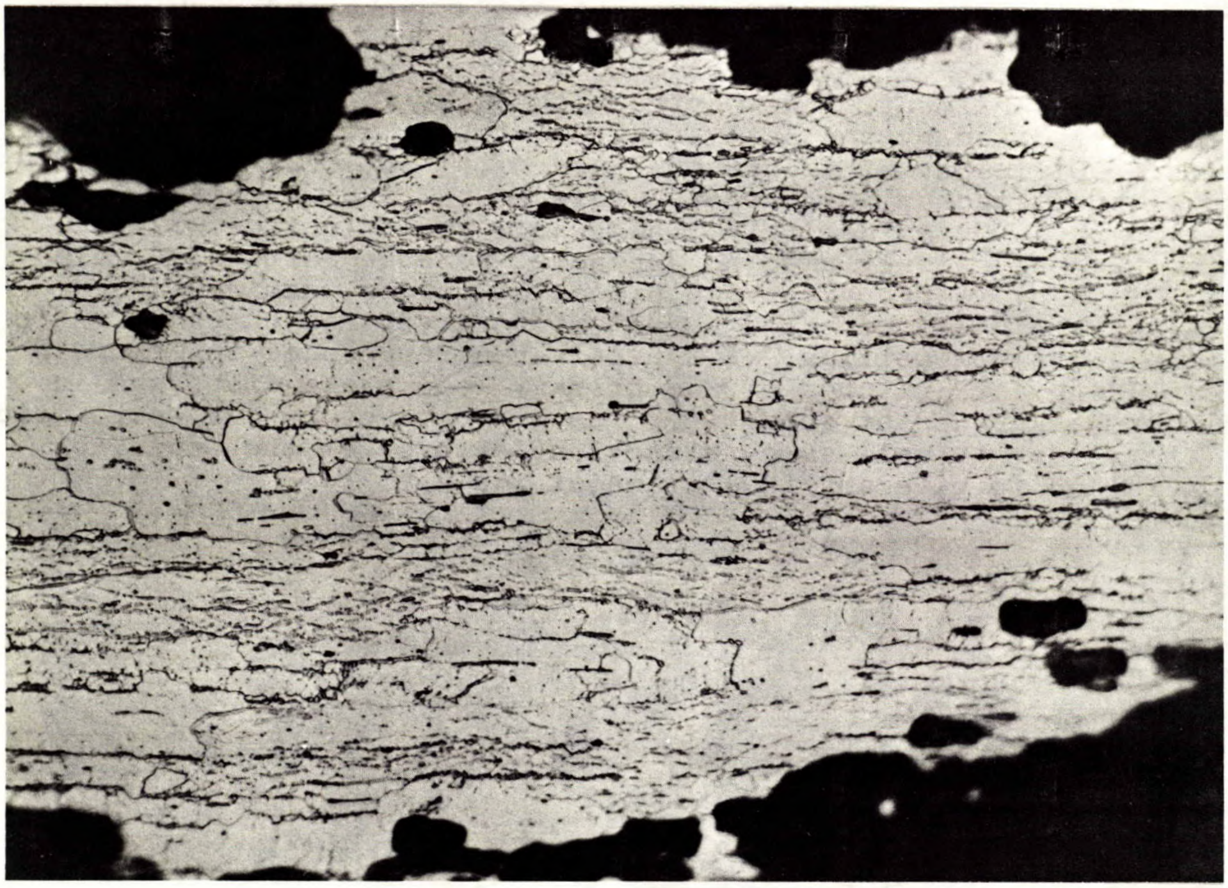
Figure 4. "Cocoa" tin from beside Stefansson's Cairn (arrow 1, Figure 2).
The ferrite is oriented and relatively coarse. This structure can be produced by cooling of hot rolled packs through the temperature range 732-538°C (1350-1000°F). The finishing temperature during rolling was below the A_c3 temperature.

X500 etched 2% nital

Figure 5. Same sample as above.
Illustrates the elongated coarse ferritic microstructure with traces of coarse grain boundary carbide produced by rolling at a finishing temperature below the A_c3 temperature, followed by slow cooling of the pack through the temperature range 732-538°C (1350-1000°F).

X100 - etched 2% nital

Figure 6. Transverse section through basis steel from corroded pemmican container.
The microstructure consists of coarsened and deformed ferrite grains with bands of spheroidized carbide. No Al_2O_3 inclusions were observed.

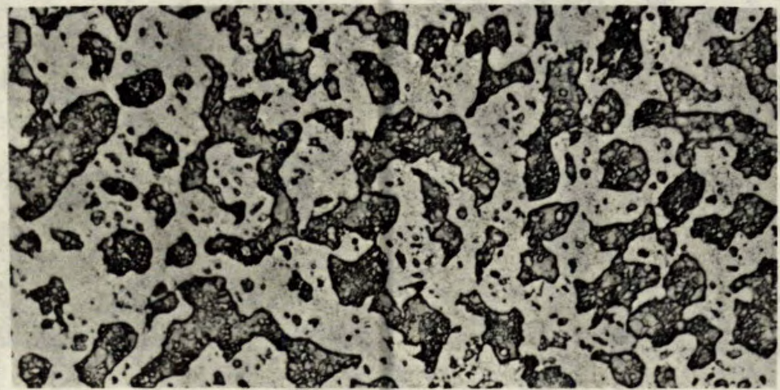


X500 - etched in 2% nital

Figure 7. Part of same area as shown in Figure 6. The appearance of the steel suggests that the finishing temperature after hot pack-rolling was below the A_c3 temperature and that spheroidization and grain growth occurred in the interval of time during which the pack cooled from the final rolling temperature through the temperature range 705 to 538°C (1300 to 1000°F).

(3) Solder Joints and Tin Coating on Pemmican Can

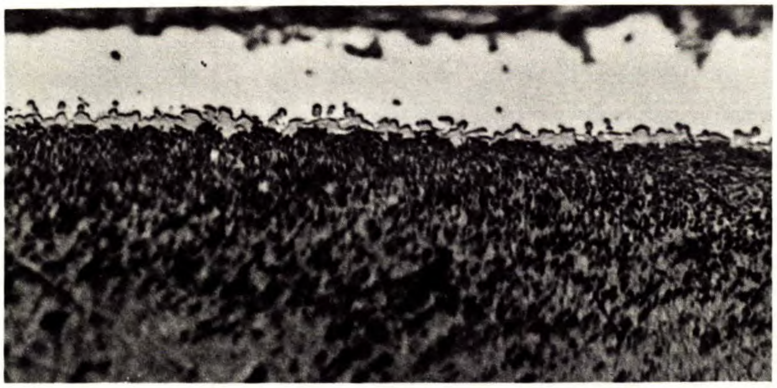
From the pieces remaining of the large rectangular container (pemmican tin) it was seen that the corners had been formed by hand soldering of simple lap joints. Blobs of excess solder still intact were removed by melting and analysed chemically for tin and antimony, and spectrographically for bismuth. The results reported by the Analytical Chemistry Subdivision, Mineral Sciences Division, Mines Branch, were 47.5% Sn, 0.31% Sb, 0.03% Bi and balance lead by difference. This composition approximates to a 50-50 Pb-Sn solder (alloy 50B, ASTM specification B32-49) which has been widely used as a general purpose soft solder alloy for very many years. Separate pieces of solder examined metallographically revealed normal microstructures characteristic of the above composition. A typical area reproduced in Figure 8 shows large dark patches of the primary lead phase dispersed in a light background of eutectic. The microstructure and composition of the solder as well as construction features of the container thus failed to give any indication of its age.



X500 - unetched

Figure 8. Microstructure of solder from pemmican can joint.

Despite the very advanced stage of general and pitting corrosion of the pemmican container, recognizable tinned areas remained on one of the side walls. Pieces from these areas were removed for metallographic examination and after considerable experimentation, some success in reproduction of the tin coating microstructure was achieved with a taper mounting and polishing technique. Patches of coating still intact and not undermined by steel base corrosion showed some variation in total thickness but in general conformed to the structure illustrated in Figure 9. A well-defined iron-tin alloy layer of appreciable thickness adjacent to the steel base shows that the coating was applied by the hot dipping technique and not by electrolytic deposition as widely used in current practice. The average overall thickness of the coating also suggested a hot dipped coating. This was of the order of 0.00013 in. (about 2 lb, 2 oz/basis box) which is in excess of the normal maximum coating thickness (0.75 lb/basis box) applied in electrolytic tin plate manufacture.

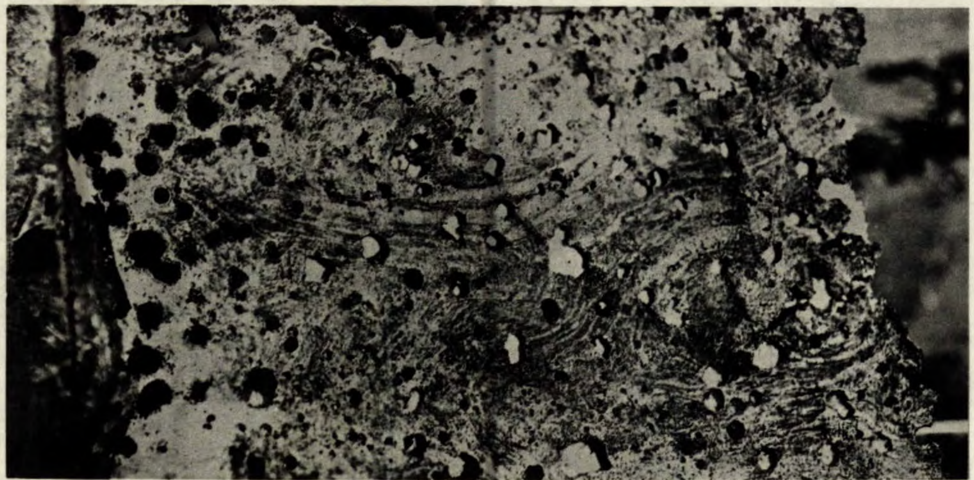


X1500 - etched in 5% picral solution.

Figure 9. Microstructure of tin coating on pemmican can.

Insofar as dating of the container is concerned, it is to be noted that up to 1947 the bulk of U.S. tin plate production was based on the hot dipping process and, as late as 1960, such coatings represented in excess of 5% of total production. The fact that the coating was applied by hot dipping is thus of negligible value in establishing the age of the container. It can, however, be conjectured that this predates 1942 for a number of reasons. The measured coating weight of 2 lb, 2/oz basis box exceeds the normal range for commercial hot dip coatings (1.0-1.75 lb/basis box) and would be considered excessive for a similar application by present day standards. Also, in 1942, severe curtailment and strict measures of economy in the use of tin were enforced in the U.S. This greatly accelerated the growth of the electrolytic tin plate industry and the related and general trend towards marked reduction in thickness of tin coatings.

A further test attempted was the selective removal by acid stripping of the outer tin layer from additional sample pieces chosen. The results of this examination also were not conclusive since only on one piece out of the several tested was the characteristic mottle or swirl pattern revealed on the exposed surface of the iron-tin alloy layer. The pattern found is illustrated in Figure 10. This effect is typical of a normal iron-tin alloy structure on hot dipped tin plate which has been produced with zinc chloride as the fluxing agent. It is of interest in the present case since a palm oil cover on the tin bath was still widely used sixty years ago and fluxing by the chloride method found limited application only at that time. In view of this, it would probably be reasonable to assume that the container sheet showing the characteristic mottle pattern was produced sometime after 1910 from which it follows that the container did not originate with the Cook expedition of 1908. No explanation can be given for the reproduction of the iron-tin alloy pattern on only one of the several sample pieces stripped. Modification of the stripping reaction because of the advanced corrosion of the samples, particularly by pitting, was presumably involved.



X5

Figure 10. Mottle pattern on surface of iron-tin alloy layer exposed by stripping of outer tin layer.

SUMMARY OF OBSERVATIONS

Use of zinc chloride as a flux during tinning of one of the plates in the pemmican container suggested that this tin plate was probably manufactured sometime after 1910.

Dating by study of the solder and of the basis steel composition and structure were not conclusive. However, the steel in both the pemmican tin and "cocoa" tin appear to have been manufactured from rimmed acid Bessemer steel by the hot pack-rolling technique. These procedures were well established in the period 1900 to 1935.

The "cocoa" tin appeared to be less severely corroded than the other cans in question, this is possibly explained by the fact that the cairn location was drained and protected, whereas the pemmican container and the small round can were in a wetter and more exposed location.

It is of interest to note that the seam present in the round can (Figure 3) was machine-soldered.

CONCLUSIONS

(1) The use of zinc chloride flux, introduced in 1910, seems to prove that the pemmican can was manufactured later than 1908 and hence did not originate with the Cook expedition.

(2) The containers were probably manufactured in the period 1910 to 1942. Circumstantial evidence suggests that these were left by Stefansson or Krueger. V. Stefansson's accounts indicate (The Friendly Arctic, Chapter LI, p. 521) that on June 17, 1916, two men in his party did camp near the site illustrated in Figure 1.