A REPORT

ON THE ESTABLISHMENT

OF PRECISE ASTRONOMIC STATIONS

ALONG

THE ALBERTA-NORTHWEST TERRITORIES BOUNDARY

BETWEEN THE MACKENZIE HIGHWAY AND THE LITTLE BUFFALO R.

SEASON OF 1950

W.D. FORRESTER

GEODETIC SURVEY OF CANADA

At the request of the Alberta-Northwest Territories Boundary Commission, comprised of J.H. Holloway, Commissioner for Alberta, and B.W. Waugh, Commissioner for the Dominion, the task of completing the astronomic location of the Alberta-Northwest Territories boundary was commenced during the month of January, 1950. The Commission accepted the existing survey and monumentation of the boundary established by the former Topographical Surveys Branch of the Department of the Interior between Fort Smith and the Little Buffalo River. This survey was run from an observation monument erected by C. Engler, D.L.S., in the vicinity of Fort Smith, to a monument erected by H. Parry, D.T.S., in the vicinity of the Little Buffalo River. The monument marking the northern terminus of the Alberta-Saskatchewan boundary was also declared satisfactory to the Alberta-Northwest Territories Boundary Commission as a marker for the eastern terminus of the Alberta-Northwest Territories boundary. Thus, the task projected for myself and my colleagues was to observe as many precise astronomic stations as possible along the 60th parallel of latitude at approximately 24 mile intervals between the Alberta-British Columbia border and the Little Buffalo River. To complete the job would require about ten stations.

A complete treatment of the project must start in Ottawa in the month of November, 1949, when overtures were first made to determine who in the office would react favourably to a suggestion to spend three months of the winter in the field. Although mostly everyone was willing to help out, it was decided that the Astronomic Division could not spare more than two men from the job of calculating the previous summer's record yield of northern mapping control points. As a result, Art Shama of the Astronomic Division was

chosen to act as my recorder and assistant, and Pat Monaghan was borrowed from the Shoran Division to act as a second assistant.

The decision was made to undertake this operation in the winter because muskegs and swamps render most of the area impassable in the summer, and because there are not sufficient lakes properly spaced along the border to make water landings at the stations feasible. The Topographical Survey was already engaged in consultations with the Bond Construction Company of Edmonton and Hay River to hire bulldozers and a tractor train to assist in running a survey line from the intersection of the Mackenzie Highway and the 60th parallel westward roughly along the 60th parallel. Thus, it seemed logical for us to make use of the cut trail that they would leave. Tractor train seemed to be the best method of winter transport available to the astronomic party because of the great weight of instruments, radios, batteries, recording apparatus, and food that would be required. Since any future work along the 60th parallel would be to the west of the Alberta-British Columbia border, it was considered advisable to complete the section of the work from the Mackenzie Highway eastward to the Little Buffalo River first, so that any stations not completed this winter would lie close to the future projects. Arrangements were made, in keeping with this plan, for the Bond Construction Company to supply the Geodetic Survey with a bulldozer to cut a trail eastward from the Mackenzie Highway, and with another tractor train to carry the observing party along this trail behind the bulldozer. Only one tractor was to be used later on the western section, since a trail would already have been cut by the Topographical Survey. Bond Construction Company was to be completely responsible for boarding the surveyors as well

as its own crews on the trip.

The travel arrangements mentioned above fortunately removed the worries of transport and supply from the shoulders of the surveyors, whose shoulders were already well weighed down with the difficulties of acquiring clothing suitable for temperatures of 60° below zero, but not too clumsy for observing in; making determinations as to which of our theodolites could possibly be used at such low temperatures; getting the instruments winterized; designing arrangements to keep the batteries warm while in use outside; and devising a method of communication between the observing tent and caboose which would allow the recorder and recording apparatus to remain in the warmth, where both could operate much more efficiently. For a complete description of our preparations for and findings on winter clothing and winter observing, see the reports on these subjects appended at the back of this folder.

The tasks of choosing clothing and foreseeing difficulties in observing were rather difficult ones since no one in our office as yet had acquired any experience on winter operations. However, we finally reached a state of what we considered to be complete preparation, and on the evening of January 11, 1950, with minds at ease, we placed ourselves in the care of the Canadian National Railways for delivery to Edmonton.

In Edmonton, contact was made with Mr. E.M. Taylor of the Bond Construction Company and the contract was signed and forwarded to Ottawa for the signature of the Minister of Mines and Resources. We were informed by Mr. Taylor that there had been a delay in dispatching the Topographical Survey's party from Hay River, and that it would avoid congestion if we would postpone our arrival at Hay River from January 17 to January 19. He estimated that we should be able to get our

party on the road by Sunday, January 22. After purchasing snowshoes and a few articles of clothing in Edmonton, we boarded a Canadian Pacific Airlines plane on January 19, and arrived in Hay River the same day. Not until the Topographic party left on the next morning was work commenced on our outfit. From January 20 until January 29 we waited in Hay River while workmen prepared three cabooses and two fuel sleighs, overhauled an International TD 18 bulldozer, and made repairs on an old inactive Cletrac tractor for use on our expedition. Our communications from Ottawa with the Bond Construction Company in Edmonton had led us to believe that we could pull out of Hay River as soon after January 15 as we wished, so that this delay was an unpleasant surprise.

Our plans called for Pat Monaghan to go ahead with the bulldozer crew of two men with a living caboose and a fuel sleigh. Pat was to navigate the bulldozer outfit to keep them close to the 60th parallel, to take preliminary latitude shots with a theodolite, and thus to choose station sites on good ground along the trail within the required 20 chains of the true 60th parallel. Art Shama and I were to follow with the second tractor train with its crew of three in two cabooses and with another fuel sleigh. The bulldozer outfit left Hay River on January 29, and the second train got away on February 1. The trip from Hay River down the Mackenzie Highway for 80 miles to the 60th parallel took about 24 hours of travelling for both of the trains. We arrived with the second train at the border on February 3, and found the trail cut to the west by the Topographic party, and the trail cut to the east by our bulldozer train, which had arrived there two days earlier.

We established our first station site at the intersection of the Topographic's trail with the Mackenzie Highway, and designated it "LAT VI" as instructed. Both of our outfits

were equipped with Marconi CS 11-A transceivers, so that we were able to keep in touch with each other and with the Bond Construction Company base radio at Hay River. On February 6, we learned from Pat Monaghan over the radio that the bulldozer outfit was now about 15 miles east of the highway and progressing favourably. Our observations were proceeding against clouds and 40° below temperatures as well as could be expected, and it began to look as if we had finally seen the end of our delays, and would now be able to clean up the operation in jig time. However, the next news from the bulldozer outfit was that the bulldozer had broken through the frozen surface of the muskeg on February 8, and was now resting comfortably with its blade holding it from sinking deeper, and most of the remainder submerged. On the next night, February 9, Art and I completed the precise observations for this station and on the following morning packed everything up for moving.

Plans were made for our outfit to wait at the highway until another D 8 caterpillar tractor arrived from Hay River; we were then to cut enough big timber for the construction of a salvage tripod and haul it in to the sunken bulldozer, where no timber of any size was available. Our own Cletrac tractor was giving trouble in starting, so the batteries were sent by truck to Hay River to be recharged. On the morning of February 12, the D 8 arrived, and we moved across the Hay River to cut the required timbers. In descending the west bank of the river, the weight of the cabooses jack-knifed the Cletrac, breaking the bunting pole between it and the fuel sleigh. However, with the help of the D 8 we got straightened out and made a safe crossing. Fifteen timbers, 20 feet long and about 15 inches in diameter, were cut and fastened on behind the D 8 to be towed in from the Hay River. The country here was flat with large trees about

Mishap descending west bank of Hay River, showing jack-knifed train and broken bunting pole.

TD 18 at rest in muskeg grave east of Yates River.

75 feet high around the rivers and larger lakes, and patches of scrubby muskeg and burned over areas between. The trees around the Hay River and Swan Lake were mostly large spruce, tamarack, poplar, and birch. In between were encountered scrubby swamp spruce and tamarack. On February 14, Dick Bond caught up to our train with a Bombardier snowmobile and driver carrying a Herman-Nelson heater to thaw out the TD 18 when salvaged, and cables with block and tackle to use as a hoist on the tripod. The outfit then proceeded from Swan Lake for about 7 miles, only to have to send the D 8 back to pick up some birch logs to make spreaders for the runners on the sleighs. These spreaders are wooden bars placed between the runners to prevent them from toeing in or out; the frozen humps of muskeg being passed over caused the cabooses to pitch so violently that the bunting poles, used to keep the cabooses apart, were pushing against the spreaders and breaking them. The two men who returned to Swan Lake with the D 8 for spreaders finally returned on foot after a 7-mile walk through a blizzard to report that all the fuel oil used as antifreeze in the radiator of the D 8 had leaked out and that they had had to abandon it. One of them had the left side of his face uncomfortably frozen. The next day the Bombardier carried fuel oil to the stranded D 8, and the spreader logs were hauled up from Swan Lake. After this, we proceeded through scrub spruce, tamarack, burned over patches, and humpy muskeg, until we finally reached the scene of the sunken bulldozer, about 25 miles from the highway, on the evening of February 16.

Since the countryside was covered with about 2 feet of snow, one had to judge the nature of the ground below by the type of growth showing above the snow. The country around the sunken TD 18 seemed to be much the same kind of muskeg as we had been passing through, with scrub spruce trees 10 or 15 feet high; however, the actual spot in which the bulldozer chose to

Tripod of 20 ft. timbers erected over TD 18

Another view of tripod over sunken bulldozer

break through was part of a "ravine". These "ravines" are merely low stretches of land with no trees or bushes growing on them, and run mostly north and south in this part of the country. They are usually made up of bogs and marshes, and may possibly be parts of old stream beds. At any rate, one such bog in one such ravine had made a very good attempt to devour our bulldozer, as the accompanying photographs may show. For some reason, the ground here had not properly frozen; possibly partly because of some "anti-freeze" chemical in the water and partly because of heavy snowfalls blanketing the ground before the frost had gone deep enough. To show how surprisingly weak the frozen surface was here I need merely relate that Pat Monaghan and I both had the experience of sinking up to our knees in the mud and slush while walking close to the sunken cat. These events served to verify the advice given us by an old Indian who heard of the plight of the TD 18. His recommendation for choosing ground safe to travel over was concise and to the point - "No sticks, no go!"

For the next two weeks everyone's attention was focussed on the TD 18. A footing of timbers was frozen in around the cat, a tripod was erected on this footing, and block and tackle was hung from the tripod. It was Dick Bond's intention to hook a cable on to the drawbar at the rear of the cat, and as this drawbar was about 5 feet below the surface of the water, mud, and slush, attempts were made to lower the water level with forestry pumps. These attempts failed only because the pumps were not quite fast enough, however, the water level was lowered by as much as 2 feet for a short while. Meanwhile, the Bombardier had been making several trips to Hay River and two aircraft had also flown from Hay River with more pumps and some "experts" on salvage operations. The experts did much poking at the cat with sticks and much shaking

TD 18 rising out of the mud and slush.

Transferring cable onto drawbar
to lift bulldozer higher.

of their heads, but finally returned to Hay River with the cat still as far down as ever. Eventually it was decided to abandon the idea of hooking the drawbar and to hook three cables onto three weaker, but accessible parts of the cat. This was done; the Cletrac was used as a "dead man" attached by a cable to one side of the tripod; the D 8 pulled from the other side on the hoist cable; and the TD 18 arose from the grave shrouded in ice and mud. Logs were placed under the raised cat and it was then lowered onto the logs to be towed to solid ground by the D 8. A tent was put around the TD 18 and heated by the Herman-Nelson heater for two days to thaw the ice off the cat. By the evening of March 2, the bulldozer was once again ready to work.

During this long delay, Pat, Art and I had observed a star fix at the site of the mishap, transferred our position by means of the vertical aerial photographs to the Yates River, and snowshoed the 3 miles to the river to identify the site of our next station. We were forced to move on to the river because there was no good ground on which to establish a station before that. It was unfortunate that no replacement bulldozer with blade was available to cut a trail to the river earlier so that we could have been observing while the TD 18 was being salvaged.

Being mobile again, a trail was bulldozed by the TD 18 to the Yates River, and both trains moved on to the chosen station site. Here a link in the track of the TD 18 was noticed to be broken. The next day a new link was flown in and the track repaired. The ground along the river was a light brown clay with a few small stones in it. Large spruce and poplar lined the river banks. While Art and I were observing here, the bulldozer outfit moved ahead to clear the trail to the next station, which we planned to establish at the Whitesand River. As the banks of the Yates River were

Tripod topples as TD 18 is pulled out from under it.

TD 18, covered with ice and mud, resting on logs at the edge of its former prison.

quite steep, it was necessary to build approaches by scraping brush and small trees up with the bulldozer and pushing them over the bank to form a ramp. Snow was then plowed onto this brush ramp for the sleighs to slide on. We arrived at this station on March 3, and completed the observing on the night of March 9. The Cletrac now refused to start even though it was thoroughly heated up. Apparently its batteries were still too weak. Since it was sitting right near the crest of a fair-sized hill, I suggested that we push it down the hill to try to start it. This was done by jacking the track around from behind, one link at a time, until we had the tractor teetering on the brink. We then heated the engine, filled the radiator with hot fuel oil, and strapped a blow-torch onto the side with its flame playing into the air intake. The driver then mounted the cat, released the brake, and tried to start it as it lumbered lazily down the hill. The machine coughed and chugged two or three times to show that it was honestly trying, but, in its old age, it just didn't seem to have the will to live.

We got in touch with Pat Monaghan on the radio and arranged for the TD 18 to come back from the Whitesand River to start the Cletrac. It arrived the next day, March 10. After being towed for 15 minutes steady, the Cletrac finally woke up. Giving the Cletrac only one sleigh to pull, we proceeded on to the Whitesand River, where we arrived the next day. In coming from the Yates River to the Whitesand, we passed through spruce about 60 feet tall on the west bank of the Yates, through large birch and poplar on the east bank, and then into humpy muskeg country with scrub spruce on it. We crossed some bald prairie and a stream that the bulldozer had had to fill in completely with brush. The last part of the trip was over very rough muskeg with humps of frozen moss

10 or 12 feet across and 3 or 4 feet high. We placed our station in the jack-pine groves that lined the west bank of the Whitesand River. The Cletrac had been dying a slow death ever since it left the Yates River, and now scarcely seemed able to perambulate even by itself. Dick Bond informed us over the radio that he would come in by plane to try to repair the Cletrac, an old veteran of the Canol project. We tried to discourage this because the ice on the river was so undermined and caved in that we believed a plane landing would be too dangerous. The plane, with Dick aboard, flew over the next day, but did not land on the hazardous river ice. We were told to leave the Cletrac behind and proceed as best we could with one tractor, the TD 18.

We finished observing this station on the night of March 14, and the next day the bulldozer returned from 5 miles beyond to pick us up. The procedure now consisted of the bulldozer working ahead with one caboose and fuel sleigh while we were observing, and then returning to pick up our two cabooses when we had finished observing. The complete train of 3 cabooses and a fuel sleigh was then moved right along with the bulldozer until the next station was reached.

The river had been banked on both sides with brush and snow to make approaches, and brush had been pushed by the bulldozer quite far out on the river to cover the weakest looking ice. We passed through the jack-pine that lined both sides of the Whitesand and passed into muskeg country, again with the usual spruce and tamarack. Now and again we encountered a small jack-pine grove; it was important to watch for jack-pine since they always indicate sandy or gravelly soil, which makes an excellent spot for a permanent

Tractor train crossing Whitesand River. Note ramp of brush and snow down river bank.

Piece of tractor road through spruce trees near Whitesand River. Road is about 14 feet wide.

station mark. About 5 miles east of the Whitesand we came to a creek about 50 feet across, which had had to be completely filled in with brush and snow since the ice was hanging, and hence, too dangerous for crossing over. The creek was lined with spruce of as much as a foot in diameter. We moved along behind the bulldozer until March 19, when we reached a suitable spot for the next station, to the east of Buchan Lake. We had been travelling over the same humpy muskeg and through the odd jack-pine grove all the way. Buchan Lake did not have any large growth around it, but seemed to be totally surrounded by muskeg. A stream flowing out of the east end of the lake smelled of sulphur, and had remained unfrozen all winter. We placed our station in a grove of jack-pine 60 feet tall about 3 miles beyond Buchan Lake. There was also an unfrozen stream near here smelling strongly of sulphur.

On the night of March 21 we completed observations at this station, Lat. III, and the next day the bulldozer returned to pick us up. We moved on to the limit of the trail on the west side of the Buffalo River after passing through small spruce all the way from the last station. To the north of us most of the way on this trip was heavy jack-pine either alive or burned over. It was necessary to build approaches up the banks of the Buffalo River also. On the west side of the river were huge deadfalls, and on the east side we had to cut through about a half a mile of thick spruce, birch, poplar, and jack-pine, some of which were well over a hundred feet high. We then moved on through muskeg country past a small lake, and on to a spot we had chosen from the photographs as being a likely-looking grove of jack-pine. We arrived at this station site on March 24, and completed observations on the night of March 26.

Tractor train crossing unfrozen sulphur stream.
Note the bridge of brush and snow across stream.

Caboose wedged against trees in heavy timber on
east side of the Buffalo River.

The snow had begun to get soft, and was now actually melting quite alarmingly; where it had been scraped to about a depth of 4 inches on the trail, it had now disappeared, leaving the trail bare. We travelled all night through muskeg, marsh, and bald prairie until we reached the proposed site for "LAT I". This site was chosen near the northeast corner of the lake shown on the map on the border at longitude 115°48' W. However, Pat Monaghan's preliminary star shots indicated this lake to be marked about 2 miles too far south on the map, so we had to move around the east end of the lake and down slightly to the south of it to establish the station. We arrived at this station on March 29, but did not complete it until the night of April 2 because of cloudy weather.

On April 3, we started the return trip to Hay River since it was far too late to contemplate tackling any further stations to the west of the highway. The trip back was trying, because most of the snow had melted off the trail, and the TD 18 had great difficulty pulling the sleighs over some bare spots. It was often necessary to break the train up and take it over the worst spots in two sections.

Snags were quite troublesome both on the trip in and the trip out. These snags are trees lying in the trail or at the side of the trail, and if one wedges itself between the ground and part of the caboose, it will tear its way right through the floor or wall until it has run its course. Snags can be quite dangerous if anyone chooses to ride inside the caboose, although we fortunately had no injuries. One snag took the bench right out from under the cook; another came through the pantry, scrambling a case of eggs and knocking over the heater stove; another broke the copper water reservoir off the cook stove; and still another one took a shelf of dishes

"Tourist" surveyors running to photograph buffalo (in background) West of "Lat I".

off the kitchen wall, accounting for several plates and creating a few flying saucers.

At the Whitesand River we picked up the Cletrac and brought it back with us, but it was unable to pull any load. We reached the highway on Easter Sunday, April 9. The highway was mostly bare of snow, and after struggling along it for about 50 miles the Cletrac and cabooses were abandoned along the side of the road. The cabooses would be picked up by tractor if there were another snowfall, and if not, they would be brought in later on trucks. The metal shoes on the sleigh runners were being worn right through by the dragging over the bare gravel. The shoes got so hot that steam was rising from the road under each runner. A truck came out from Hay River to carry our equipment back, and we arrived at Hay River on Tuesday, April 11.

After packing everything for shipment to Ottawa, we found that the "ban" was now on the Mackenzie Highway for any vehicle heavier than ½ ton. Since the Hay River airport was predicted to be unserviceable by the day of the next plane out, (this was later verified when the plane was unable to land because of mud) we hired a ½ ton truck with a driver to take us down the highway to Grimshaw. This was a hectic trip over, or rather through, muddy roads with a truck that had obviously already well earned its superannuation. However, we reached Grimshaw, after 28 hours of solid driving, on April 15. Arriving in Edmonton by bus, on April 16, we paid our respects to the Edmonton office of the Bond Construction Company, and left by train for Ottawa on April 17, to arrive home safely on April 20.

Looking back on the operation, I should say that the Bond Construction Company co-operated with us to the full of their ability, and did their best to accommodate us. My

only criticisms would be that the Cletrac tractor supplied was not in fit condition for such a trip, and that liaison between Edmonton and Hay River was poor, since the estimated departure time given us by their Edmonton office was an obvious impossibility to any one knowing the stage of preparations in Hay River. I also agree with the recommendation of R.J. Parlee of the Topographical Survey that, in future contracts, payment for tractor trains should be by the hour, with an additional daily payment for lodging the surveyors, since it is impossible to expect such outfits to cling to an eight hour working day. Other than the Cletrac, the rest of the equipment supplied was excellent. The cabooses were insulated and hence warm at the floor as well as the ceiling, and the TD 18 was in very good shape. Had the TD 18 not suffered the misfortune of sinking, it could have carried the full load by itself all the way, and we could have completed our goal of 10 stations.

The winter's experience would lead me to recommend a TD 18 or a D 7 as the ideal size of tractor for this work. A D 6 would be too light to rely upon, and a D 8 is actually heavier than required. I cannot stress too much the necessity of good equipment on such a trip as this, and in the future, I should recommend that the department obtain reliable appraisals of any equipment that is to be supplied before the expedition reaches the field. For a discussion of various methods of winter travel in completing this project, please see the appended report at the back of this folder.

Description of Astronomic Station, "LAT. VI"

This station was placed on the west side of the Mackenzie Highway at the southwest corner of the intersection made by the highway and the tractor trail cut by the Topographical Survey in 1950. The road signs marking the approximate Alberta-Northwest Territories boundary are on the northwest corner of this same intersection. The Geodetic Survey's trail, cut this year by our party, turns off the highway towards the east about a quarter of a mile north of the station site.

The station mark is a regulation ¾" steel pipe post about 2½ feet in length with "LAT. VI" marked with a cold chisel on one side of the squared top. The post is sunk into the ground to within about 6" of the top and covered over with a mound of dirt 6 feet in diameter. Surrounding the mound is a trench about a foot wide and a foot deep. The mound was 3 feet high when built, but, since it was made of frozen dirt, it may be somewhat smaller when it thaws.

Bearing Trees

BT_1 is a white poplar about 10" in base diameter and approximately 50 feet from the eastern edge of the highway. It is 2 or 3 trees deep in the woods, but is on a clear line of sight from the station mark. It is marked by a 2½ foot blaze on the side of the tree facing the station mark.

Azimuth from station mark to BT_1 = $39^{\circ}38.'8$

BT_2 is a white poplar about 10" in base diameter and approximately 50 feet from the east side of the highway. Four or five small trees had to be cleared out of the bush to give a clear line of sight to the station mark. The tree is marked by a 2½ foot blaze on the side facing the station mark.

Azimuth from station mark to BT_2 = 128°18'.1

BT_3 is a white poplar about 6" in base diameter approximately 500 feet west of the highway at the northern edge of the Topographical Survey's trail. It is marked by a 2½ foot blaze on the side of the tree facing the station mark, and has a clear line of sight to the station mark.

Azimuth from station mark to BT_3 = 275°05'.6

General Description

The country around the station is flat and quite heavily wooded with white and black poplar, spruce, and jack-pine 50 or 60 ft. tall. The Indian cabins marked on the sketch are permanently inhabited. A line of sight had been cut at some previous date from the station F 127, established by John Russel on the Hay River, to the approximate intersection of the highway with the boundary.

The precise level bench mark 866-H is just to the north of the boundary road signs. It is a small concrete monument with a Geodetic bronze tablet embedded in it, and a white wooden post, with "BM" painted on it in black, standing behind the monument.

Photographic Identification

The pinpoint inside the red circle on the accompanying photograph, A11860-319, marks the station site as well as could be done from the ground. The pinpoint is accurate to at least 300 feet.

PLAN

SHOWING TOPOGRAPHY ADJACENT TO

LAT. VI - ASTRONOMIC STATION.

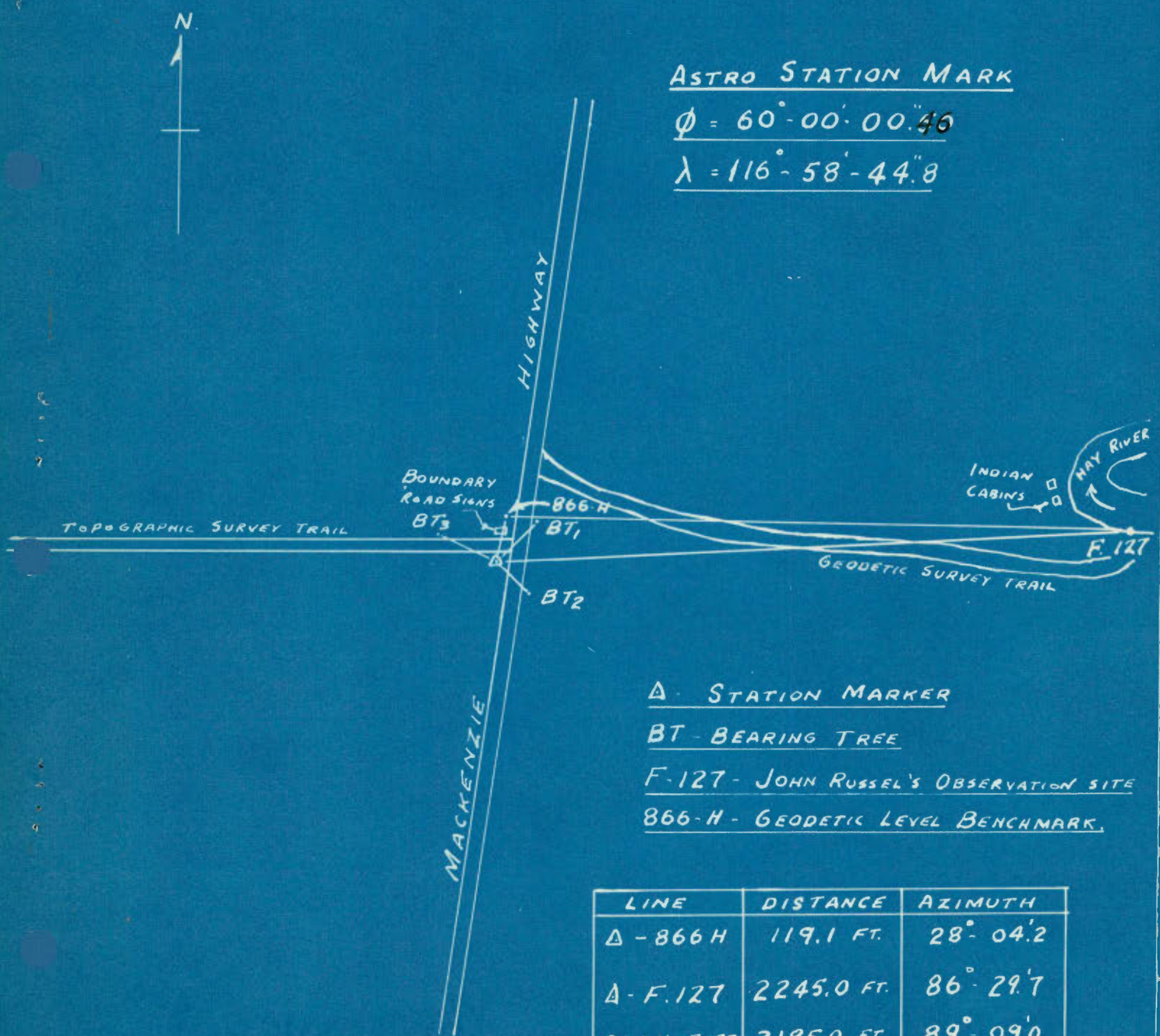
ALBERTA - NORTHWEST TERRITORIES

BOUNDARY SURVEY.

FEB. 9, 1950.

W. D. FORRESTER.

FILE NO. 1229.



Δ STATION MARKER

BT - BEARING TREE

F-127 - JOHN RUSSEL'S OBSERVATION SITE

866-H - GEODETIC LEVEL BENCHMARK.

LINE	DISTANCE	AZIMUTH
Δ - 866 H	119.1 FT.	28° - 04'.2
Δ - F. 127	2245.0 FT.	86° - 29'.7
866 H - F. 127	2185.0 FT.	89° - 09'.0
Δ - BT_1		39° - 38'.8
Δ - BT_2		128° - 18'.1
Δ - BT_3		275° - 05'.6


ALTA. - N.W.T BOUNDARY
STATION LAT VI
LAT. VI
A11860-319

Digging station mark in front of observing tent.

Looking west from highway along Topographic Survey trail.

Looking north along Mackenzie Highway, showing station marker at left.

TABULATION OF OBSERVATIONS AT STATION LAT. VI

Date	Latitude	V	V^2
Feb. 8, 1950	59° 59' 60".27	0.45	0.20
" 9	59.44	1.28	1.64
" "	60.23	0.49	0.24
" "	61.77	1.05	1.10
" "	60.05	0.67	0.45
" "	62.68	1.96	3.84
" "	59.85	0.87	0.76
" "	61.59	0.87	0.76
" "	59.85	0.89	0.79
" "	59.09	1.63	2.66
" "	62.52	1.80	3.24
" "	58.92	1.80	3.24
" "	59.73	0.99	0.98
" "	60.02	0.70	0.49
" "	59.98	0.74	0.55
" "	59.65	1.07	1.14
" "	61.50	0.78	0.61
" "	60.68	0.04	0.00
" "	60.88	0.16	0.03
" "	60.40	0.32	0.10
Feb. 10	59.46	1.26	1.59
" "	61.68	0.96	0.92
" "	60.16	0.56	0.31
" "	60.36	0.36	0.13
" "	61.81	1.09	1.19
" "	61.57	0.85	0.72
" "	60.19	0.53	0.28
" "	60.52	0.20	0.04
" "	58.84	1.88	3.53

TABULATION OF OBSERVATIONS AT STATION LAT. VI (Continued)

Date	Latitude	V	V^2
Feb. 10, 1950	59° 59' 61".94	1.22	1.49
" "	62.91	2.19	4.80
" "	60.81	0.09	0.00
" "	61.49	0.77	0.59
" "	62.35	1.63	2.66
" "	60.84	0.12	0.01
" "	61.06	0.34	0.12
" "	60.49	0.23	0.05
" "	61.26	0.54	0.29
" "	61.69	0.97	0.94
" "	59.48	1.24	1.54
" "	61.49	0.77	0.59
		Sum of V^2 =	44.61

Probable error of result = ± 0".11

Mean value of 41 pairs = 60° 00' 00".72 ± 0".11
Reduction to site of marker = -00".22
Reduction to sea level = -00".04
Latitude of Post LAT. VI = 60 00 00.46 ± 0.11

Longitude

February 7, 1950 = 116° 58' 44".8
Reduction to site of marker = 00".0
Longitude of Post LAT. VI = 116° 58' 44".8

Description of Astronomic Station, "LAT. V"

This station was placed in a poplar "burn" about 300 yards from the west bank of the Yates River.

The station mark is a regulation ¾" steel pipe post about 2½ feet long with "LAT. V" marked with a cold chisel on one side of the squared top. The post was sunk to within 6" of its length into the ground; a trench 18 inches wide, 12 inches deep, and 6 feet across was dug around the post; and the dirt removed from this trench was piled on the post to form a mound. A triped of dead trees approximately 12 feet in length was erected with its legs resting in the trench, to mark the spot when snowdrifts cover the mound.

Bearing Trees

BT_1 is a dead poplar tree about 6 inches in base diameter sawed off 4 ft. high. A 4" spike was driven into the top of this stump with 2" of the spike protruding.

Azimuth from station mark to BT_1 = $45^{\circ}30.'8$

BT_2 is a dead poplar tree 6" in base diameter sawed off 4 ft. high with a 4" spike protruding 2" from the top of the stump.

Azimuth from station mark to BT_2 = $226^{\circ}15.'2$

BT_3 is a dead poplar tree about 4" in base diameter sawed off 4 ft. high with a 4" spike protruding 2" from its top.

Azimuth from station mark to BT_3 = $323^{\circ}54.'8$

All bearing trees have a clear line of sight to station marker, and all are blazed on the side facing the marker, although the blaze may not remain very noticeably in the dead wood.

General Description

The area around the station is covered with a "burn" of poplar and spruce about 30 or 40 ft. tall and

8 inches in diameter. The ground is flat, but drops down about 40 ft. to the river level. The actual banks of the river are about 6 ft. high. Along the river are patches of live spruce 50 ft. tall and 18 inches across. To help mark the station site, a line 500 ft. long was bulldozed through the dead poplar north and south from the station site.

Photographic Identification

The pinpoint inside the red circle on the accompanying photograph, A11860-304, marks the station site as well as could be done from the ground. The pinpoint is accurate to at least 300 ft.

PLAN

SHOWING TOPOGRAPHY ADJACENT TO

LAT. V - ASTRONOMIC STATION.

BOUNDARY SURVEY

ALBERTA - NORTHWEST TERRITORIES

MARCH 9, 1950.

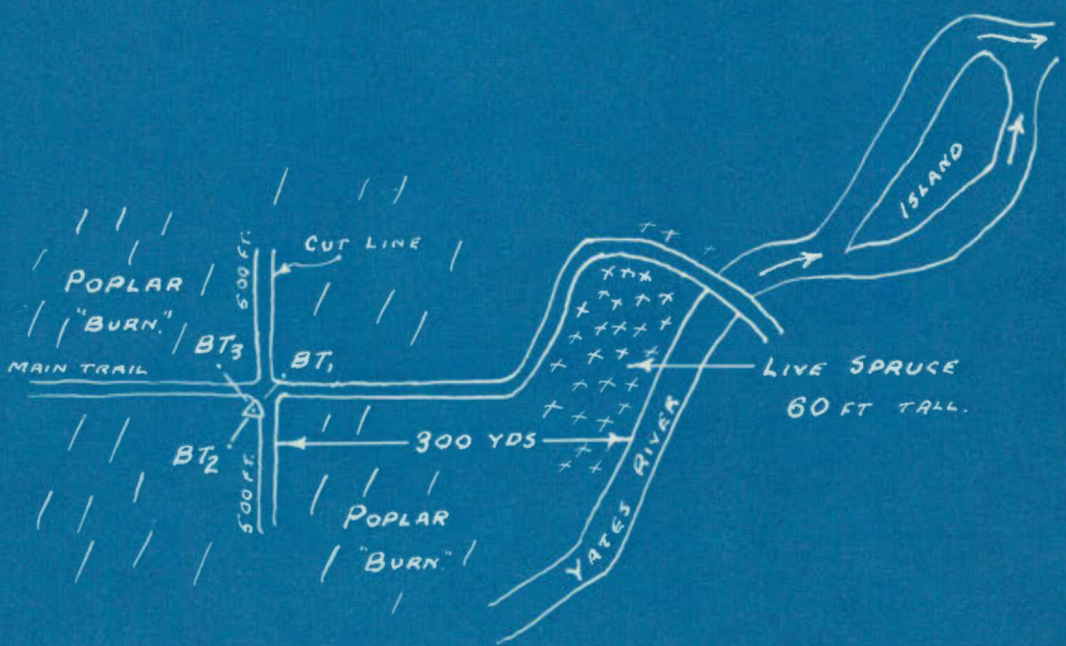
W. D. FORRESTER. FILE No. 1228.

N

ASTRO STATION MARK

$\phi = 59^\circ - 59' - 57.69''$

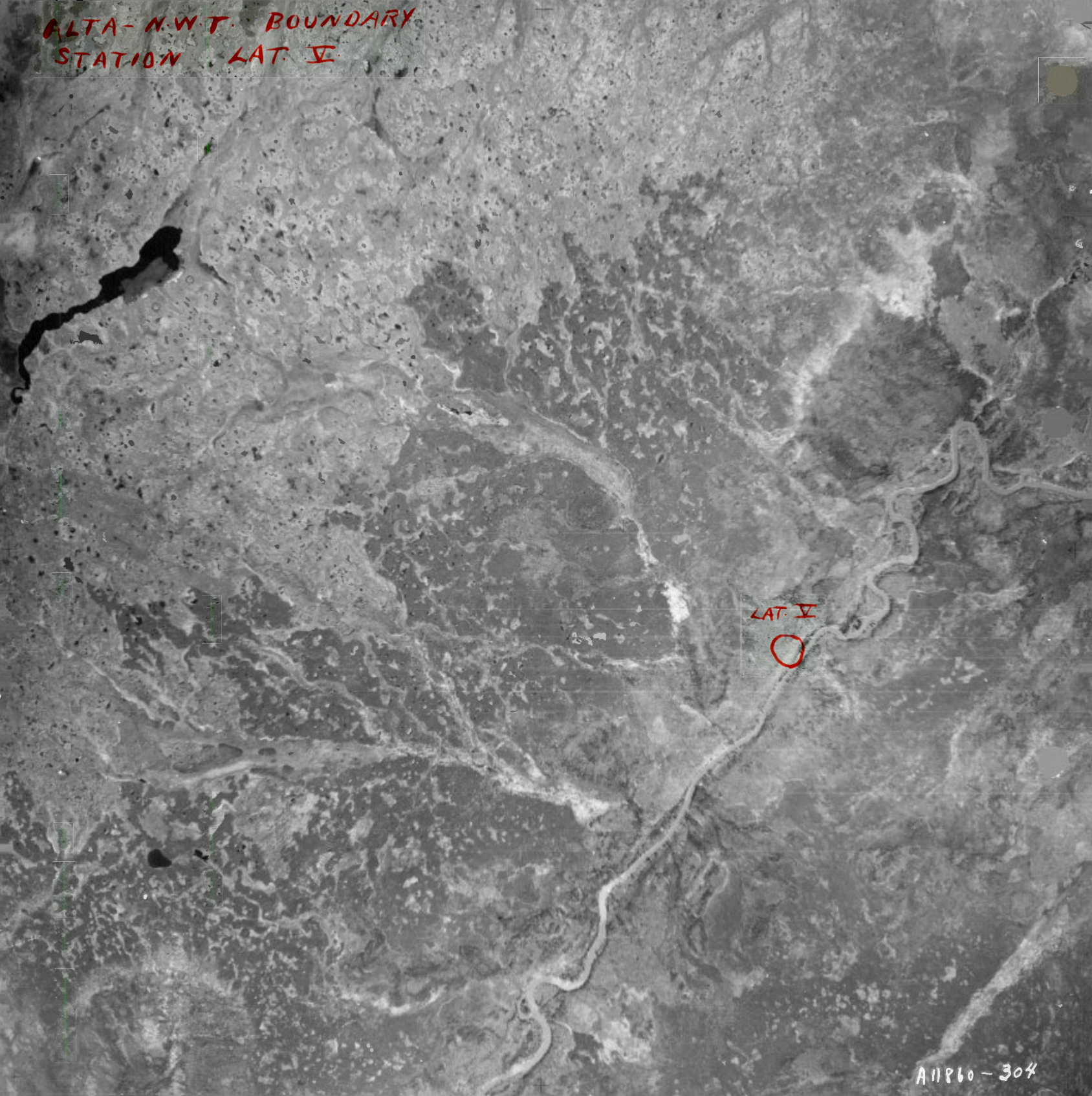
$\lambda = 116^\circ - 04' - 58.62''$



Δ - STATION MARK.

BT - BEARING TREE.

LINE	DISTANCE	AZIMUTH
Δ - BT_1	64.0 FT.	45° - 31'
Δ - BT_2	64.6 FT.	226° - 15'
Δ - BT_3	80.0 FT.	323° - 55'


ALTA-N.W.T. BOUNDARY
STATION LAT. V
LAT. V
A11860-304

Observing tent and theodolite, looking east along trail before station mark erected.

Looking west along trail after station mark erected.

Station mark, looking north from trail along cut line.

TABULATION OF OBSERVATIONS AT STATION LAT. V

Date	Latitude	V	V^2
March 6, 1950	59° 59' 59".04	1.50	2.25
" "	57.62	0.08	0.01
" "	57.45	0.09	0.01
" "	59.26	1.72	2.96
" "	57.54	0.20	0.04
" "	58.01	0.47	0.22
" "	56.81	0.73	0.53
" "	58.26	0.72	0.52
" "	56.66	0.88	0.77
" "	56.64	0.90	0.81
" "	56.77	0.77	0.59
" "	57.63	0.09	0.01
" "	58.03	0.49	0.24
" "	57.62	0.08	0.01
" "	58.37	0.83	0.69
" "	57.79	0.25	0.06
" "	58.17	0.63	0.40
" "	57.69	0.15	0.02
" "	57.13	0.41	0.17
" "	57.74	0.20	0.04
" "	57.74	0.20	0.04
" "	56.45	1.09	1.19
" "	56.86	0.68	0.46
March 8	57.51	0.03	0.00
" "	57.29	0.25	0.06
" "	57.56	0.02	0.00
" "	58.40	0.86	0.74
" "	57.20	0.34	0.12
" "	57.18	0.26	0.07

TABULATION OF OBSERVATIONS AT STATION LAT. V (Continued)

Date	Latitude	V	V^2
March 8, 1950	59° 59' 57".77	0.23	0.05
" "	57.50	0.04	0.00
" "	58.05	0.51	0.26
" "	56.68	0.86	0.74
" "	58.15	0.61	0.37
" "	57.29	0.25	0.06
" "	57.25	0.29	0.08
" "	58.32	0.78	0.61
March 9	56.23	1.31	1.72
" "	57.43	0.11	0.01
" "	57.08	0.46	0.21
" "	56.87	0.67	0.45
" "	57.47	0.07	0.00
" "	57.84	0.30	0.09
" "	57.63	0.09	0.01
		Sum of V^2 =	17.69

Probable error result = ±0".07

Mean value of 44 pairs = 59° 59' 57".54 ± 0".07

Reduction to site of marker = 00".19

Reduction to sea level = -00".04

Latitude of Post LAT. V = 59° 59' 57".69 ± 0".07

Longitude

March 4, 1950 = 116° 04' 58".62

Reduction to site of marker = 00".00

Longitude of Post LAT. V = 116° 04' 58".62

Description of Astronomic Station, "LAT. IV"

This station was placed on the west side of the Whitesand River. The accompanying sketch map shows the location of the station relative to the river and the rather complicated trail. The complications in the trail were caused here by the decision that the spot where we first hit the river was unsuitable for crossing, and by the fact that preliminary star shots showed us that we had to cut south to place the station near the border.

The station marker is a regulation ¾" steel pipe post 2½ ft. long with "LAT. IV" marked with a cold chisel on one side of the squared top. Since the post would only drive about a foot into the frozen ground here without bending, it was not sunk quite as deep as the posts at the other stations. A trench 12 inches wide and 10 inches deep was dug in a 6 ft. circle around the post, and the post was covered by a mound of dirt removed from the trench. A triped of 10 ft. jack-pine poles was erected over the marker, with its legs resting in the trench.

Bearing Trees

The three bearing trees, BT_1, BT_2, and BT_3, are all live jack-pine about 7 inches in base diameter with a 2½ ft. blaze on the side of the tree facing the station marker. The lower branches of all 3 trees were cut off so that the trunks are bare for 6 ft. from the ground. Each tree has a clear line of sight to the station marker.

General Description

The trees along the river here are mostly 30 ft. jack-pine 6 or 8 inches thick. Back away from the river is mostly scrub spruce and muskeg. Just south of the station site, the ground drops about 30 ft. into a gully populated by dead spruce. The station itself is in a jack-pine grove. The ground at the station site was covered with about 5 inches

of moss and ice; below this was a brown sandy clay frozen extremely hard. The road was cut about 400 ft. farther south than the station site to provide a line running north and south from the station.

Photographic Identification

The photographs taken of this boundary area missed the location of this station, passing to the north of it, so this station could not be identified.

PLAN

SHOWING TOPOGRAPHY ADJACENT TO

LAT. IV. ASTRONOMIC STATION.

ALBERTA - NORTHWEST TERRITORIES

BOUNDARY SURVEY.

MARCH 14, 1950.

W. D. FORRESTER.

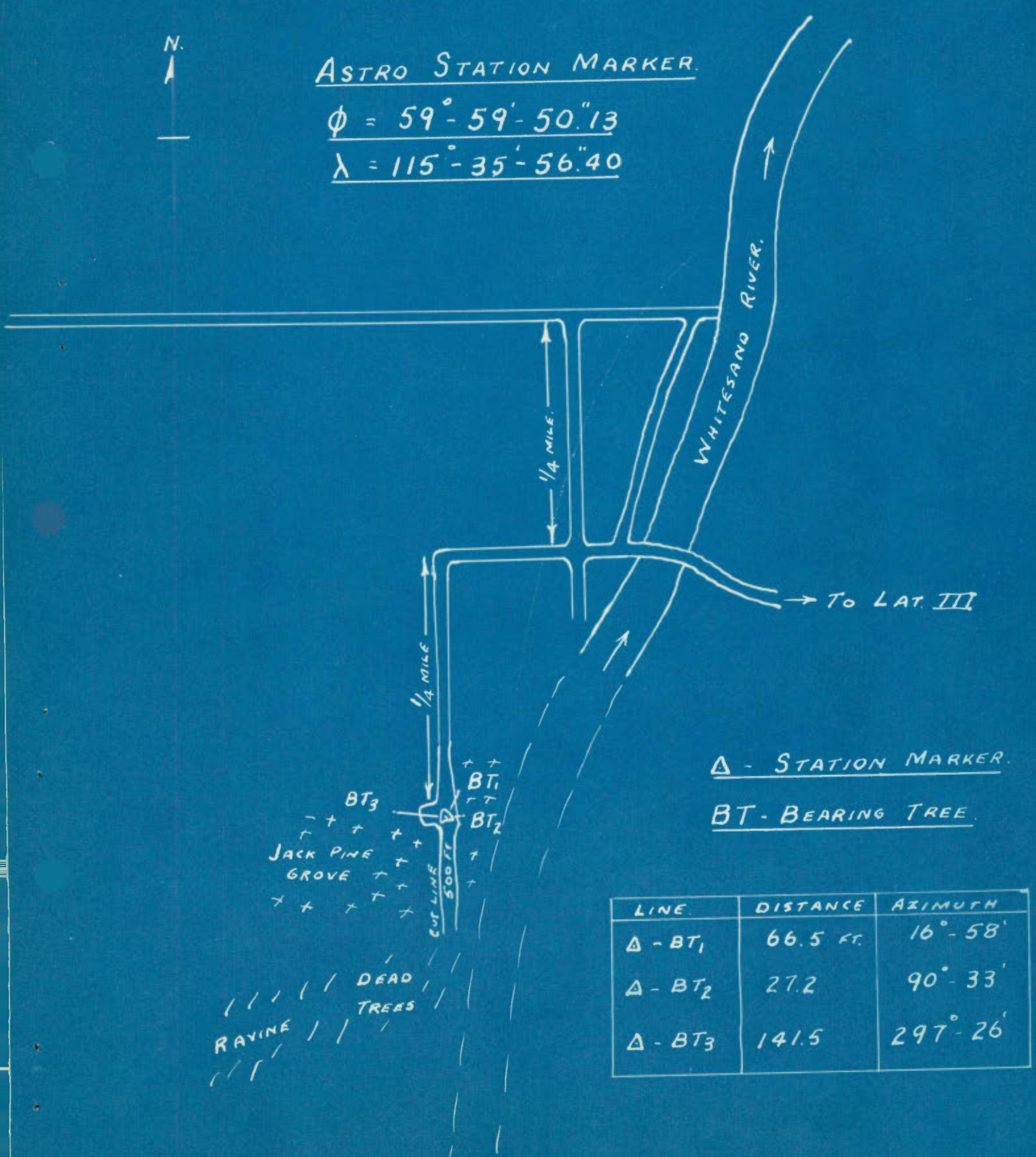
FILE No. 1227.

N.

ASTRO STATION MARKER.

$\phi = 59^\circ - 59' - 50.''13$

$\lambda = 115^\circ - 35' - 56.''40$



Δ - STATION MARKER.

BT - BEARING TREE.

LINE	DISTANCE	AZIMUTH
Δ - BT_1	66.5 FT.	16° - 58'
Δ - BT_2	27.2	90° - 33'
Δ - BT_3	141.5	297° - 26'

Incomplete station mark, and observing tent, looking north along trail.

Looking south along cut line through jack-pine grove into ravine.

Looking south of east at completed station mark.

TABULATION OF OBSERVATIONS AT STATION LAT. IV

Date	Latitude	V	V^2
March 12, 1950	59° 59' 50".50	0.05	0.00
" "	50.18	0.27	0.07
" "	52.01	1.56	2.43
" "	49.26	1.19	1.42
" "	50.37	0.08	0.01
" "	51.27	0.82	0.68
" "	52.25	1.80	3.24
" "	50.56	0.11	0.01
" "	50.10	0.35	0.12
" "	50.07	0.38	0.24
" "	50.90	0.45	0.20
March 13	50.01	0.44	0.19
" "	50.21	0.24	0.06
" "	50.37	0.08	0.01
" "	49.74	0.71	0.50
" "	50.13	0.32	0.10
" "	49.69	0.76	0.58
" "	50.55	0.10	0.01
" "	49.15	1.30	1.69
" "	50.24	0.21	0.04
" "	50.41	0.04	0.00
" "	50.08	0.37	0.14
" "	50.74	0.29	0.08
" "	50.32	0.13	0.02
" "	52.08	1.63	2.66
" "	50.81	0.36	0.13
" "	51.18	0.73	0.54
" "	49.57	0.88	0.77
" "	50.08	0.37	0.14

TABULATION OF OBSERVATIONS AT STATION LAT. IV (Continued)

Date	Latitude	V	V^2
March 13, 1950	59° 59' 50".37	0.08	0.01
" "	50.86	0.41	0.17
" "	51.14	0.69	0.48
" "	49.88	0.57	0.32
" "	50.56	0.11	0.01
" "	49.21	1.24	1.54
" "	50.19	0.26	0.06
" "	51.77	1.32	1.74
" "	50.37	0.08	0.01
" "	51.60	1.15	1.32
" "	50.67	0.22	0.05
" "	49.18	1.27	1.61
		Sum of V^2 =	23.40

Probable error of result = ± 0".08

Mean value of 41 pairs = 59° 59' 50".45 ± 0".08

Reduction to site of marker = -00".32

Reduction to sea level = -00".04

Latitude of Post LAT. IV = 59° 59' 50".09 ± 0".08

Longitude

March 14, 1950 = 115° 35' 56".865

Reduction to site of marker = -00.464

Longitude of Post LAT. IV = 115° 35' 56".40

Description of Astronomic Station, "LAT. III

This station was placed about 2 miles north-east of the first lake to the east of Buchan Lake. The accompanying sketch map shows the location of the station relative to the main trail and the creek shown on the large photograph. The spur-line trail was cut to the station site because preliminary observations proved the main trail to be south of the 60th parallel at this point. Quite a bit of clearing was done at the station site to provide a clearing for the observing tent and a loop for the tractor train to turn around on.

The station mark is a regulation ¾" steel pipe post 2½ ft. long with "LAT. III" marked with a cold chisel on one side of the squared top. It is driven into the ground to within 6" of its length. A trench 18 inches wide, 12 inches deep, and 6 ft. across was dug around the stake, and the dirt removed from the trench was piled onto the stake to form a mound. A triped of 12 ft. jack-pine poles was erected over the mound with the feet of the triped resting in the trench.

Bearing Trees

BT_1 is a dead jack-pine about 8 inches thick sawed off 5 ft. high with a metal spike protruding 2 inches from the top of the stump. It is back in the "burn" to the east of the station clearing with a clear line of sight out from it to the station mark.

Azimuth from station mark to BT_1 = 86°38'

BT_2 is a live white poplar about 6 inches thick and 35 ft. tall. It is 10 ft. back in the bush, with a line of sight cleared from it to the station mark, and has a 2½ ft. blaze on the side facing the station mark.

Azimuth from station mark to BT_2 = 206°20'

BT_3 is a live jack-pine about 8 inches thick and 35 or 40 ft. tall with a 2½ ft. blaze on the side facing the station mark. It is to the north of the station clearing with a line of sight cut from it to the station mark.

Azimuth from station mark to BT_3 = 346°51'

General Description

The growth around the station is mostly live jack-pine about 40 or 50 ft. tall, along with some poplar and spruce. Running roughly east and west through these live trees and passing right over the station site is a jack-pine "burn" a hundred feet or so wide. The surface soil is sandy, with clay deeper down. Close to the surface are stones as large as 8 inches in diameter.

Photographic Identification

The red circle on the accompanying photograph, A8200-107, marks the "burn" on which the station site was located, but it was not possible from the ground to pin-point the exact station site on the photograph.

PLAN

SHOWING TOPOGRAPHY ADJACENT TO LAT. III. ASTRONOMIC STATION.

ALBERTA - NORTHWEST TERRITORIES

BOUNDARY SURVEY.

MARCH 21, 1950.

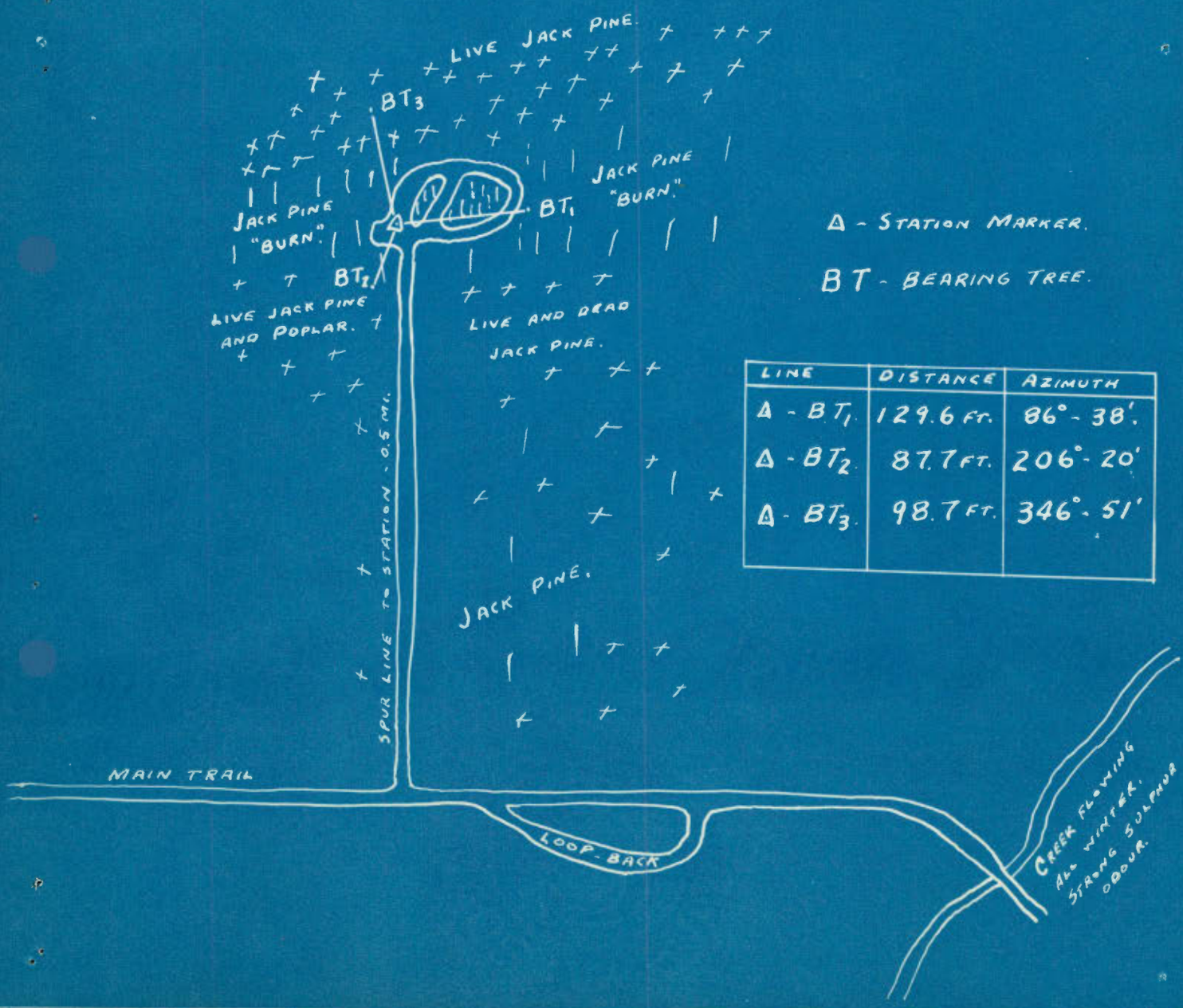
W.D. FORRESTER.

FILE No. 1226.

ASTRO STATION MARK.

$\phi = 60^\circ - 00' - 13.''95$

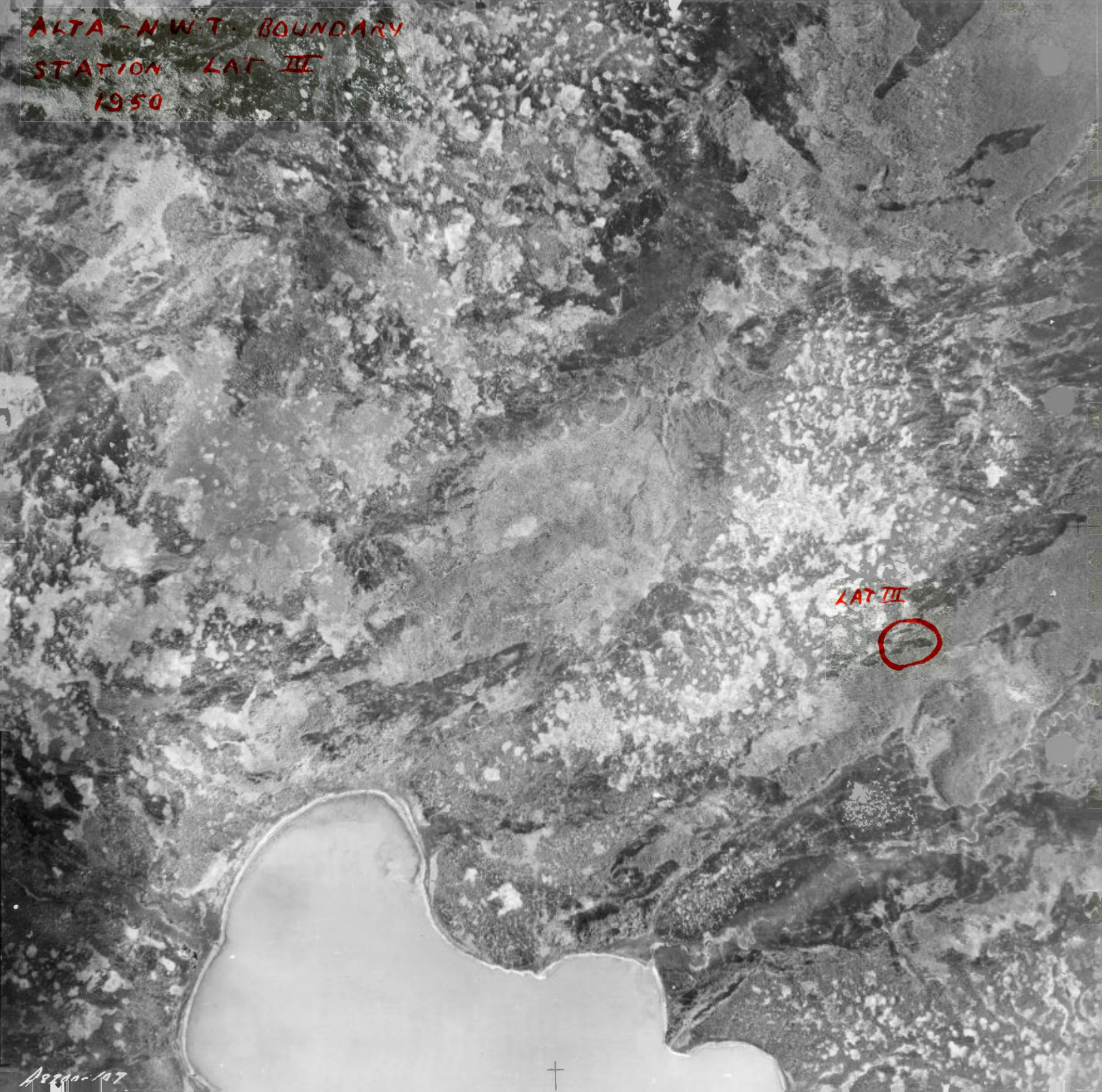
$\lambda = 114^\circ - 49' - 52.88$



Δ - STATION MARKER.

BT - BEARING TREE.

LINE	DISTANCE	AZIMUTH
Δ - BT_1	129.6 FT.	86° - 38'
Δ - BT_2	87.7 FT.	206° - 20'
Δ - BT_3	98.7 FT.	346° - 51'


ALTA - N.W.T. BOUNDARY
STATION LAT III
1950
LAT III

Incomplete station mark and observing tent, looking east along loop in trail.

Theodolite and incomplete station mark, looking northwest.

Complete station mark, looking north along loop in trail.

TABULATION OF OBSERVATIONS AT STATION LAT. III

Date	Latitude	V	V^2
March 20, 1950	60° 00' 15".64	0.00	0.00
" "	13.28	0.36	0.13
" "	13.56	0.08	0.01
" "	12.82	0.82	0.67
" "	14.06	0.42	0.17
" "	13.29	0.35	0.12
" "	13.12	0.52	0.27
" "	13.74	0.10	0.01
" "	14.19	0.55	0.30
" "	13.83	0.19	0.04
" "	13.43	0.21	0.04
" "	13.83	0.19	0.04
" "	13.41	0.23	0.05
" "	13.01	1.37	1.88
" "	13.95	0.31	0.10
" "	13.97	0.33	0.11
" "	14.49	0.85	0.72
March 21	14.14	0.50	0.25
" "	13.89	0.25	0.06
" "	15.93	2.29	5.28
" "	13.52	0.12	0.01
" "	15.44	1.80	3.24
" "	13.87	0.23	0.05
" "	13.72	0.08	0.01
" "	13.95	0.31	0.10
" "	13.52	0.12	0.01
" "	13.54	0.10	0.01
" "	12.15	1.49	2.23
" "	12.27	1.37	1.88

TABULATION OF OBSERVATIONS AT STATION LAT. XIX (Continued)

Date	Latitude	V	V^2
March 21, 1950	60° 00' 12".87	0.77	0.59
" "	13.41	0.23	0.05
" "	14.47	0.83	0.69
" "	13.30	0.34	0.11
" "	13.41	0.23	0.05
" "	13.38	0.26	0.07
" "	12.44	1.20	1.44
" "	13.16	0.48	0.23
" "	13.74	0.10	0.01
" "	13.31	0.33	0.11
" "	13.91	0.27	0.07
" "	12.33	1.31	1.72
		Sum of V^2 =	22.93

Probable error of result = ± 0".08

Mean value of 41 pairs = 60° 00' 13".64 ± 0".08

Reduction to site of marker = 00".31

Reduction to sea level = -00".04

Latitude of Post LAT. III = 60° 00' 13".91 ± 0".08

Longitude

March 20, 1950 = 114° 49' 52".875

Reduction to site of marker = +00".004

∴ Longitude of Post LAT.III = 114° 49' 52".88

Description of Astronomic Station, "LAT. II"

This station is located on the border at about longitude 114°21' W. in the centre of a group of 4 lakes as shown in the accompanying photograph. It is at the northeast corner of a clump of live trees.

The station marker is a regulation ¾" steel pipe post 2½ ft. long, with "LAT. II" marked with a cold chisel on one side of the squared top, sunk into the ground to all but 6 inches of its length. A trench 18 inches wide, 12 inches deep, and 6 ft. across was dug around the post, and the dirt from the trench was piled into the centre to form a mound covering the post. Over this marker a tripod of 10 ft. poles was erected with its feet resting in the trench.

Bearing Trees

BT_1 is a dead spruce about 8 inches thick sawed off 4 or 5 ft. high with a metal spike protruding 2 inches from the top of the stump. It is about 20 ft. back from the trail in a spruce "burn", with a clear line of sight from it to the station marker.

Azimuth to BT_1 from station marker = 15°59'

BT_2 is a dead spruce about 6 inches thick sawed off 5 ft. high with a metal spike protruding 2 inches from the top of the stump. It is about 100 ft. back from the station clearing in the spruce "burn", with a line of sight cleared from it to the station marker.

Azimuth to BT_2 from station marker = 151°48'

BT_3 is a dead spruce about 5 inches thick sawed off 6 ft. tall with a spike protruding 2 inches from its top. It is about 70 ft. back from the station clearing in a clump of live spruce and tamarack, with a line of sight cleared from it to the station marker.

Azimuth to BT_3 from station marker = 297°34'

General Description

The only live trees in the immediate vicinity of the station site was the grove of spruce, tamarack, and jack-pine shown in the accompanying sketch. None of these trees were more than 30 ft. tall. The rest of the area consisted of burned over spruce. The ground was flat, and contained rocks below the surface as large as 2 ft. across. A line was cut about 500 ft. south from the station marker by the bulldozer to help identify the location.

Photographic Identification

The pinpoint inside the red circle on the accompanying photograph, AS200-85, marks the station site to within 500 ft. The clump of trees shown adjacent to the station was identified on the photograph from the ground. There is a possibility that we have chosen the wrong clump of trees, but this possibility is remote.

PLAN

SHOWING TOPOGRAPHY ADJACENT TO

LAT. II. ASTRONOMIC STATION.

ALBERTA - NORTHWEST TERRITORIES

BOUNDARY SURVEY.

MARCH 26, 1950

W.D. FORRESTER.

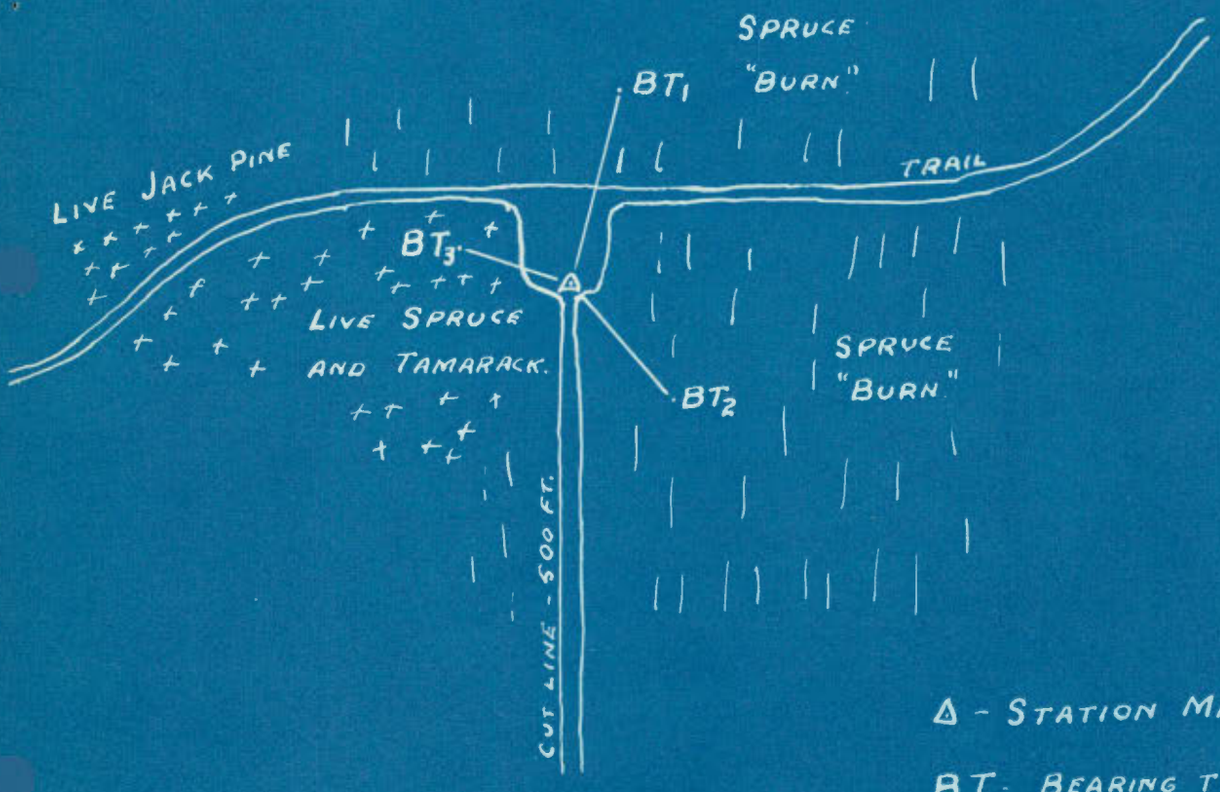
FILE No. 1225.

N.

ASTRO STATION MARK.

$\phi = 60^\circ - 00' - 14.''29$.

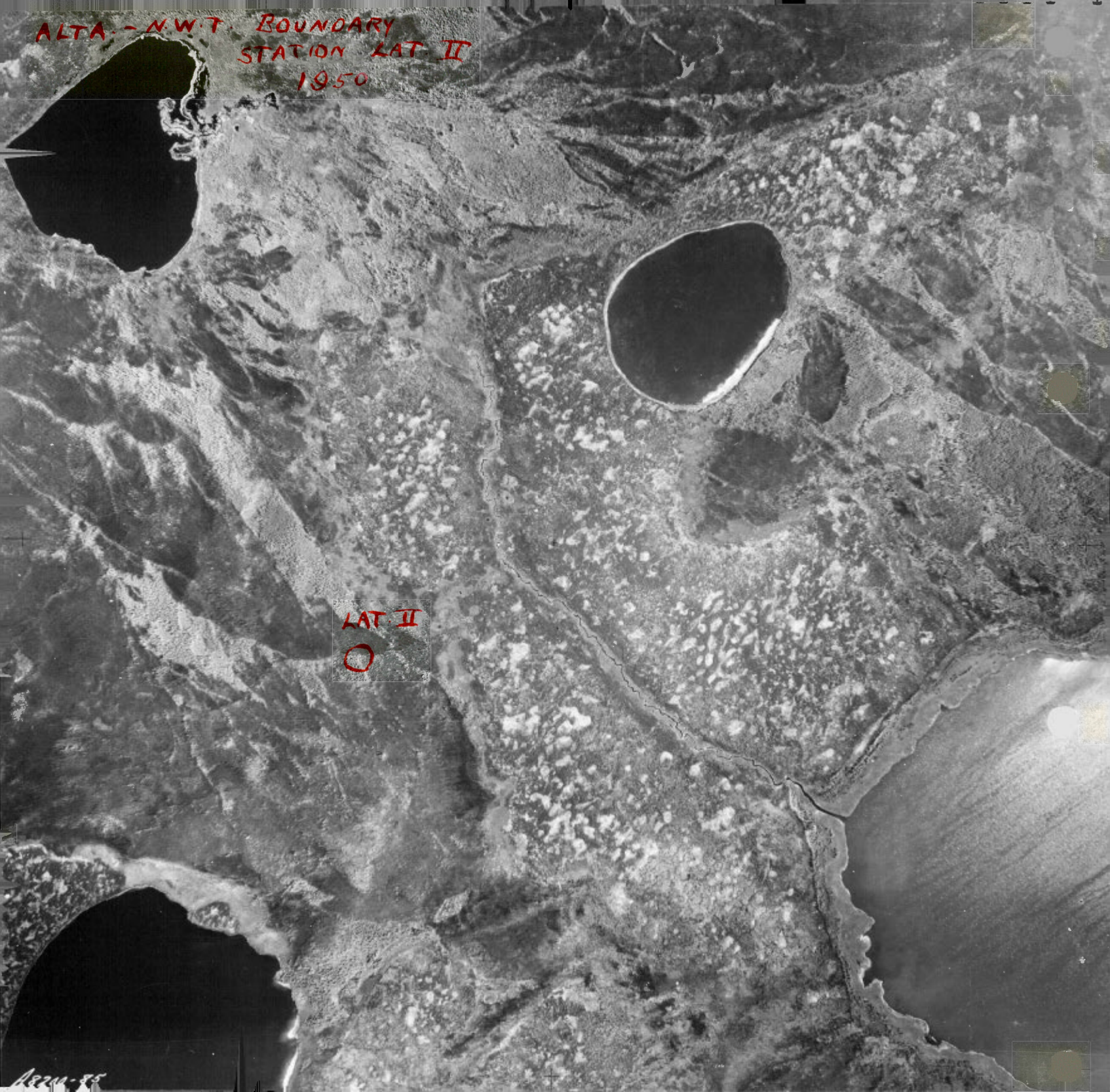
$\lambda = 114^\circ - 21' - 05.''00$.



Δ - STATION MARKER.

BT - BEARING TREE.

LINE	DISTANCE.	AZIMUTH.
Δ - BT_1	133.7 FT.	15° - 59'
Δ - BT_2	115.4 FT.	151° - 48'
Δ - BT_3	95.6 FT.	297° - 34'


ALTA. - N.W.T. BOUNDARY
STATION LAT II
1950
LAT II
O

Observing tent and cabooses, looking north from cut line.

Station marker, looking south along cut line.

Station marker and trail, looking south of west.

TABULATION OF OBSERVATIONS AT STATION LAT. II

Date	Latitude	V	V^2
March 25, 1950	60° 00' 14".65	0.01	0.00
" "	14.41	0.23	0.05
" "	15.24	0.60	0.36
" "	15.80	0.84	0.71
" "	14.75	0.11	0.01
" "	14.38	0.26	0.07
" "	15.32	0.68	0.46
" "	14.43	0.21	0.04
" "	15.11	0.47	0.22
" "	15.50	0.86	0.74
" "	14.07	0.57	0.32
" "	15.42	1.22	1.49
" "	15.79	0.85	0.72
" "	15.38	1.26	1.59
" "	14.82	0.18	0.03
" "	14.26	0.38	0.14
" "	14.67	0.03	0.00
" "	15.30	0.66	0.44
" "	15.31	0.67	0.45
" "	14.87	0.23	0.05
" "	14.59	0.05	0.00
" "	14.83	0.19	0.04
" "	15.31	0.67	0.45
" "	15.78	0.86	0.74
" "	15.81	0.85	0.69
" "	14.31	0.33	0.11
" "	14.72	0.08	0.01
" "	15.39	0.75	0.56
" "	14.73	0.09	0.01

TABULATION OF OBSERVATIONS AT STATION LAT. II (Continued)

Date	Latitude	V	V^2
March 25, 1950	60° 00' 14".30	0.34	0.12
" "	15.49	0.85	0.72
		Sum of V^2 =	11.34

Probable error of result = ± 0".07

Mean Value of 31 pairs = 60° 00' 14".61 ± 0".07
Reduction to site of marker = - 0".28
Reduction to sea level = - 0".04
Latitude of Post LAT. II = 60° 00' 14".29 ± 0".07

Longitude

March 25, 1950 = 114° 21' 05".00
Reduction to site of marker = 00".00
Longitude of Post LAT. II = 114° 21' 05".00

Description of Astronomic Station, LAT. I

This station was placed about a mile to the southeast of the eastern arm of the lake shown on the accompanying photograph. As this was the easternmost station of the enterprise, the trail looped here as is shown in the sketch map, to return along the same route.

The station marker is a regulation $\frac{3}{4}$" steel pipe post $2\frac{1}{2}$ ft. long with "LAT. I" marked with a cold chisel on one of the sides of the squared top. It was driven into the ground to within 6 inches of its length, and a trench 18 inches wide, 12 inches deep, and 6 ft. across was dug around it. The dirt removed from the trench was piled into the centre to form a mound covering the post. A triped of 12 ft. poles was erected over the marker with its feet resting in the trench.

Bearing Trees

BT_1 is a dead spruce about 5 inches thick and sawed off 5 ft. high, with 2 inches of a metal spike protruding from the top of the stump. There is a clear line of sight from the tree to the station marker.

Azimuth from station marker to BT_1 = $47^{\circ}34'$

BT_2 is also a dead spruce about 5 inches thick and sawed off 5 ft. high, with 2 inches of a metal spike protruding from its top. There is a clear line of sight from the tree to the station marker.

Azimuth from station marker to BT_2 = $137^{\circ}09'$

General Description

The station is located on a ridge running approximately east and west. To the west of the station, the ridge is covered with live spruce, while the part of the ridge containing the station is covered with a spruce "burn". South of the ridge, the land drops off into what looks like a dried up lake bottom, and south of this again is another ridge. North of the ridge containing the station,

the land drops off into a plain of grass and small shrubs.

Photographic Identification

The red circle identifying the station site on the accompanying photograph, A8200-61, is believed to enclose the station site, but no pinpointing was attempted since it was very hard to identify our exact position on this photograph from the ground.

PLAN

SHOWING TOPOGRAPHY ADJACENT TO

LAT. I. ASTRONOMIC STATION

ALBERTA - NORTHWEST - TERRITORIES

BOUNDARY SURVEY.

APRIL 2, 1950.

W. D. FORRESTER

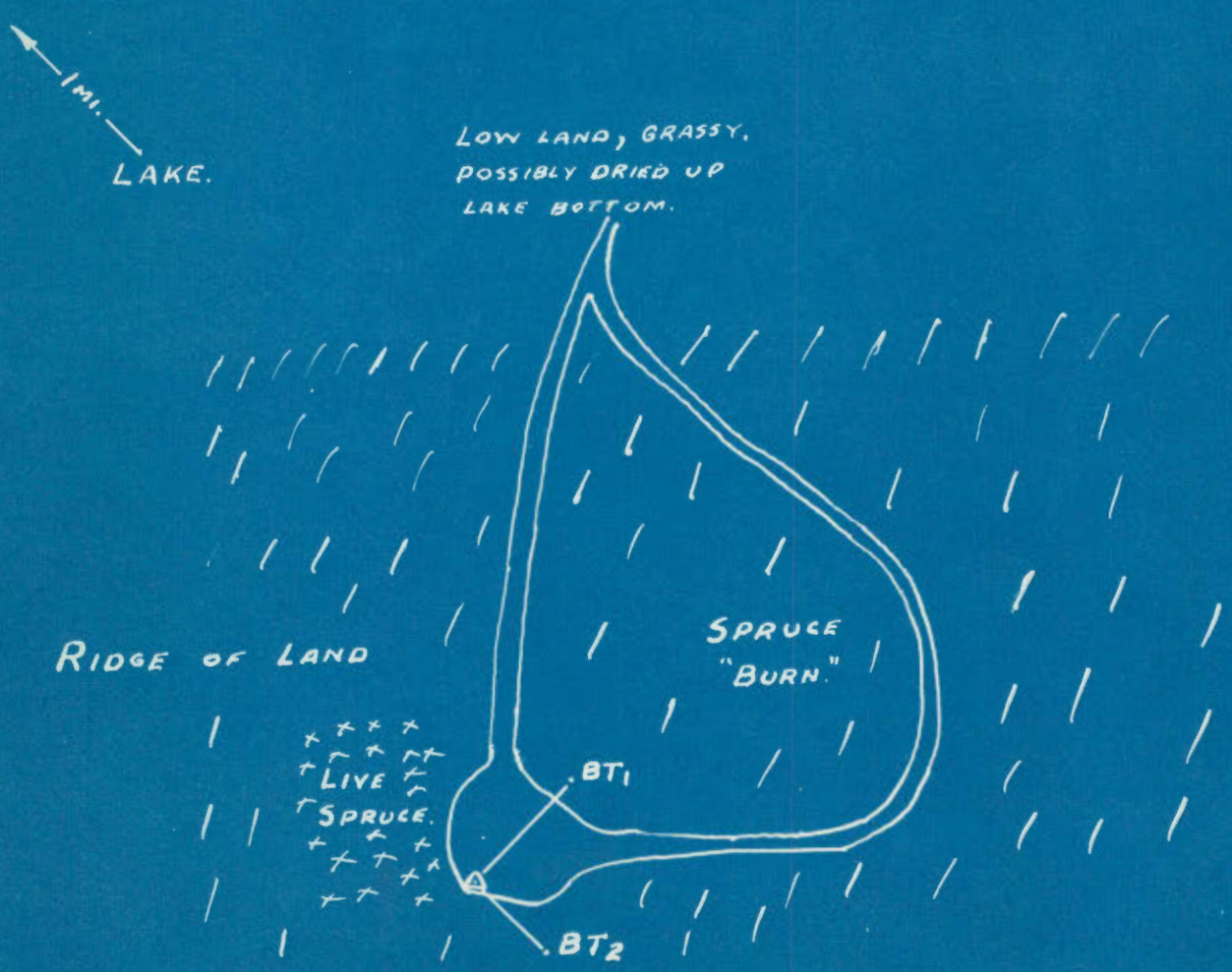
FILE No. 1224.

N.

ASTRO STATION MARK.

$\phi = 60^\circ - 00' - 17.''34$

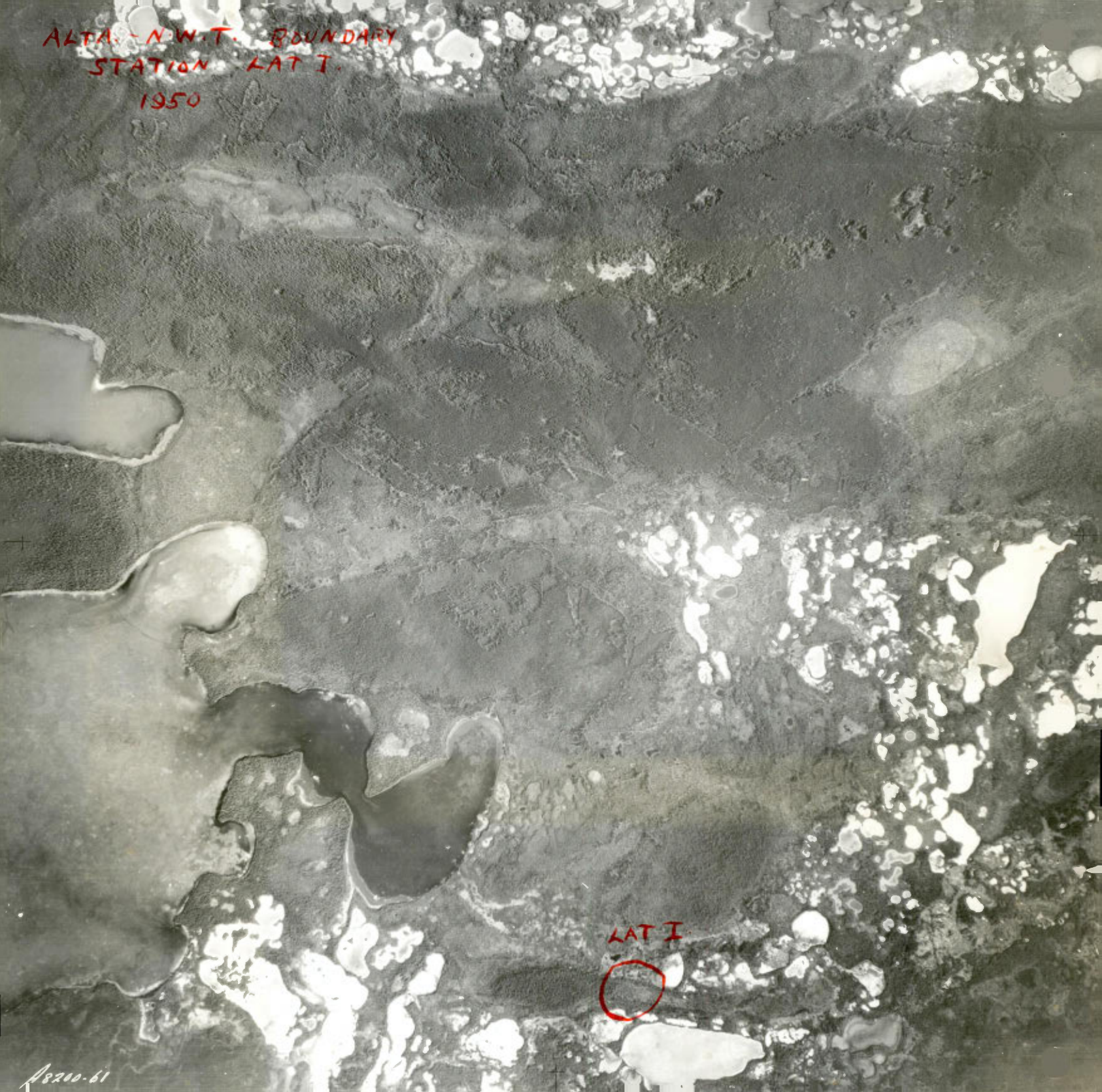
$\lambda = 113^\circ - 47' - 01.''33$



Δ = STATION MARKER.

BT - BEARING TREE.

LINE	DISTANCE	AZIMUTH
Δ - BT1	50.8 FT.	47° - 34'
Δ - BT2	41.4 FT.	137° - 09'



A8200-61

Station marker, looking west toward live spruce growth.

Station marker, looking west along loop-back in trail.

Looking south from station site through spruce "burn".

TABULATION OF OBSERVATIONS AT STATION LAT. I

Date	Latitude	V	V^2
March 31, 1950	60° 00' 16".50	0.89	0.79
" "	15.98	1.41	1.99
" "	17.27	0.12	0.01
" "	17.98	0.59	0.35
" "	17.07	0.32	0.10
" "	16.88	0.51	0.26
" "	17.90	0.51	0.26
" "	16.60	0.79	0.62
" "	16.46	0.93	0.86
" "	17.65	0.26	0.07
" "	17.07	0.32	0.10
" "	17.44	0.06	0.00
" "	17.28	0.11	0.01
" "	18.13	0.74	0.55
" "	17.25	0.14	0.03
" "	17.53	0.14	0.03
" "	17.76	0.37	0.14
" "	18.28	0.89	0.79
" "	16.81	0.58	0.34
" "	17.65	0.26	0.07
" "	18.23	0.84	0.71
" "	17.85	0.46	0.21
April 2	17.12	0.27	0.07
" "	18.02	0.63	0.40
" "	17.68	0.29	0.08
" "	16.58	0.81	0.66
" "	16.58	0.81	0.66
" "	16.44	0.95	0.90
" "	17.62	0.23	0.05

TABULATION OF OBSERVATIONS AT STATION LAT. I (Continued)

Date	Latitude	V	V^2
April 2, 1950	60° 00' 17".64	0.25	0.06
" "	17.10	0.29	0.08
" "	18.60	1.21	1.46
" "	18.71	1.32	1.74
" "	16.45	0.94	0.88
" "	17.15	0.24	0.06
" "	17.51	0.12	0.01
" "	17.52	0.13	0.02
" "	17.28	0.11	0.01
" "	17.60	0.21	0.04
" "	18.04	0.65	0.42
" "	17.74	0.35	0.12
" "	17.48	0.09	0.01
" "	17.29	0.10	0.01
		Sum of V^2 =	16.03

Probable error of result = ±0".06

Mean Value of 43 pairs = 60° 00' 17".39 ± 0".06
Reduction to site of marker = -00".05
Reduction to sea level = -00.04
Latitude of Post LAT. I = 60° 00' 17".30 ± 0".06

Longitude

March 31, 1950 = 113° 47' 00".96
Reduction to site of marker = +00".37
Longitude of Post LAT. I = 113° 47' 01".33

DAILY DIARY

1950

January 11

Left Ottawa via C.N.R. for Edmonton.

January 12

On train.

January 13

On train.

January 14

Arrived at Edmonton at midnight. Train was 16 hours late. Moved to Macdonald Hotel.

January 15

In Edmonton. As today, Sunday, no activity.

January 16

Contacted Mr. E.M. Taylor of Bond Construction. Were advised to remain in Edmonton till January 19.

January 17

Bought snowshoes, mufflers, and sheepskin trousers.

January 18

Visited at home of E.M. Taylor and discussed operation further with him.

January 19

Left Edmonton by C.P. Airlines and arrived at Hay River, N.W.T.

January 20

Topographical Survey party left from Hay River today.

January 21

Work was commenced by Bonds to prepare our cabooses.

January 22

Waiting at Hay River.

January 23

Bonds worked on TD 18 bulldozer in shop, and hauled an old Cletrac tractor out of the frozen ground where it had been for 15 months.

January 24

Waiting at Hay River.

January 25

Work on tractor trains continued.

January 26

Work still continuing on tractors and cabooses.

January 27

Still waiting.

January 28

TD 18 overhaul completed. The third caboose for our party was hauled into camp today.

January 29

TD 18 got away with Pat Monaghan, Doug. Macdonald, the tractor driver, and Pete Kalmo, the handy man.

January 30

Lloyd Orton was hired today as our cook.

January 31

Cletrac almost ready to leave.

February 1

Cletrac and its train got away today with Art Shama and I, Bill Smee, the driver, Ralph Ramey, the bull cook, and Lloyd Orton, the cook.

February 2

Arrived at border tonight.

February 3

Set up observing equipment. Cloudy tonight.

February 4

Snowing today. No observing tonight.

February 5

Ran small local survey. Observed for about an hour tonight at 40° below zero. Clouded in again.

February 6

Heard TD 18 about 15 miles from highway. Cloudy tonight.

February 7

Observed longitude tonight, but sky was too hazy to observe the faint latitude stars. Observing temperature -30° F.

February 8

Constructed station marker. Observed one pair of latitude stars. Clouded in. Observing temperature -10° F.

February 9

Heard over radio that TD 18 was down in muskeg. Completed observations at LAT. VI.

February 10

Dismantled observing apparatus and waited for a D 8 tractor to join us from Hay River.

February 11

D 8 on its way to join us.

February 12

D 8 arrived. Crossed Hay River and cut timbers for salvage of TD 18.

February 13

Arrived at Swan Lake on way to TD 18.

February 14

Dick Bond caught up to our train with a bombardier snowmobile.

February 15

D 8 returned to Swan Lake for more timbers, but broke down there.

February 16

Got D 8 mobile again, and outfit moved on to the site of the sunken TD 18.

February 17

Began building tripod footing around TD 18. Temperature low -42° F, high -20° F.

February 18

Completed building and icing footing. Temperature -40° F.

February 19

Raised tripod on footing over TD 18. Pat, Art and I observed a secondary astro fix tonight. Temperature -15° F.

February 20

Plane arrived with some blocks and pulleys. Temperature -30° F.

February 21

Fastened block and tackle to tripod. Temperature -10° F.

February 22

Dick Bond decided to try to pump water from around TD 18 with forestry pumps. Temperature -15° F.

February 23

Art, Pat and I snowshoed 1½ miles toward Yates River. Plane arrived with forestry pumps. Ralph Ramey got word his baby was sick, and he left the party by bombardier. Temperature -20° F.

February 24

Bombardier brought in replacement pumps, but could not get water level low enough. Temperature -15° F.

February 25

Continued pumping, but could not hook drawbar.

February 26

Plane arrived with "experts", and then returned to Hay River with "experts". Temperature -10° F.

February 27

Pat, Art and I completed snowshoe trail to Yates River. TD 18 was hoisted out of muskeg and left resting on logs. Temperature -10° F.

February 28

TD 18 pulled clear of hole and thawing of it was commenced. Temperature -40° F.

March 1

Continued thawing TD 18.

March 2

TD 18 was started. Replaced blade and canopy on TD 18.

March 3

TD 18 bulldozed to Yates River, and whole party then moved to Yates River, and site of station LAT. V. Temperature +16° F.

March 4

Set up observing apparatus, and observed longitude before it clouded in. Observing temperature +20° F.

March 5

TD 18 bulldozed ahead. Cloudy tonight. Temperature +15° F.

March 6

Put in station mark and bearing trees. Observed 20 pairs of latitude stars at temperature -26° F.

March 7

TD 18 still bulldozing ahead. Cloudy tonight. Temperature high 0° F, low -20° F.

March 8

Cloudy tonight, but managed to observe 15 pairs of latitude stars through breaks. Observing temperature -10° F.

March 9

Cletrac would not start. Completed latitude observations tonight at -25° F.

March 10

Dismantled observing apparatus. TD 18 returned to start Cletrac. Set out for Whitesand River.

March 11

Arrived at Whitesand River. Temperature -4° F.

March 12

Moved to site of LAT. IV and set up observing apparatus. Observed a few latitude pairs. Temperature -20° F.

March 13

Plane flew over with Dick Bond. Received instructions to leave the unserviceable Cletrac behind at Whitesand River. Completed latitude observations tonight at temperature of -30° F.

March 14

Put in station marker and bearing trees. Observed longitude tonight at temperature -27° F.

March 15

TD 18 returned and moved cabooses ahead along trail.

March 16

Joined forward party and cutting toward LAT. III was resumed. Temperature -20° F.

March 17

Bulldozed and moved to Buchan Lake. Temperature -24°F.

March 18

TD 18 fan belt broke after cutting and moving to east end of Buchan Lake. Morning temperature -16° F, but snow started to thaw in afternoon sun.

March 19

Moved to east of Buchan Lake. Polaris observations indicated we were 2,000 ft. south of border. Temperature -8°F.

March 20

Moved north to site of LAT. III. Observed longitude and 17 pairs of latitude stars. Morning temperature + 6° F. Observing temperature -10° F. Snow thawing in afternoon sun.

March 21

Put in station marker and bearing trees. Completed observations tonight. Morning temperature + 20° F, observing temperature + 8° F. Snow thawing fast in afternoon sun.

March 22

TD 18 returned and moved us up to forward outfit just west of Buffalo River.

March 23

Crossed Buffalo River and went a little beyond. Early morning temperature -6° F.

March 24

Cut and moved on to site of LAT. II, chosen from aerial photos. Set up observing apparatus, but since cloudy, could not observe. Early morning temperature + 4° F.

March 25

Marked bearing trees and put in station marker. Observed longitude and 30 pairs of latitude stars tonight. Morning temperature + 20° F. Afternoon temperature + 32° F. Snow melting fast.

March 26

Cloudy today. Lowest temperature today or tonight + 38° F. Ground now muddy, with puddles of water from melting snow.

March 27

Cloudy. TD 18 had bulldozed on to LAT. I, so returned today to await our pleasure to move. Temperature + 40° F.

March 28

Cloudy today. Decided we should move on to LAT. I tomorrow, since it was more important to complete LAT. I than to add 10 pairs of latitute stars to LAT. II. Temperature + 44° F.

March 29

Moved on to site proposed for LAT. I. Set up observing apparatus, but it was cloudy tonight. Temperature + 50° F. during afternoon.

March 30

Put in station marker and bearing trees. Cloudy with snow today. Early morning temperature + 12° F.

March 31

Observed longitude, and 20 pairs of latitude stars tonight. Observing temperature + 14° F.

April 1

Cloudy today.

April 2

Completed observations tonight at temperature + 4° F.

April 3

Dismantled observing apparatus and started return journey. Reached site of LAT. II. Had considerable difficulty drawing sleighs over trail now that snow had melted, leaving bare ground on trail.

April 4

Reached Buffalo River.

April 5

Much trouble relaying cabooses over bare trail. Reached east end of Buchan Lake.

April 6

Arrived at Whitesand River where Cletrac had been left.

April 7

Started Cletrac and moved on to Yates River.

April 8

Moved on to Swan Lake.

April 9

Reached Mackenzie Highway and started up it.

April 10

Continued along highway towards Hay River. Abandoned Cletrac alongside road and left two cabooses behind. The road was too bare to haul all three cabooses.

April 11

Arrived back at Hay River.

April 12

Packed equipment for Ottawa and sent it out by truck.

April 13

Waiting at Hay River for transport.

April 14

Left for Grimshaw in ½-ton truck.

April 15

Arrived in Grimshaw at night.

April 16

Took bus from Grimshaw to Edmonton.

April 17

Took train for Ottawa.

April 18

On train.

April 19

On train.

April 20

Arrived back in Ottawa.

REPORT ON DIFFICULTIES ENCOUNTERED IN WINTER OBSERVATIONS ALONG 60TH PARALLEL OF LATITUDE

1950

W.D. FORRESTER

GEODETIC SURVEY OF CANADA

REPORT ON DIFFICULTIES ENCOUNTERED IN WINTER OBSERVATIONS ALONG 60TH PARALLEL OF LATITUDE

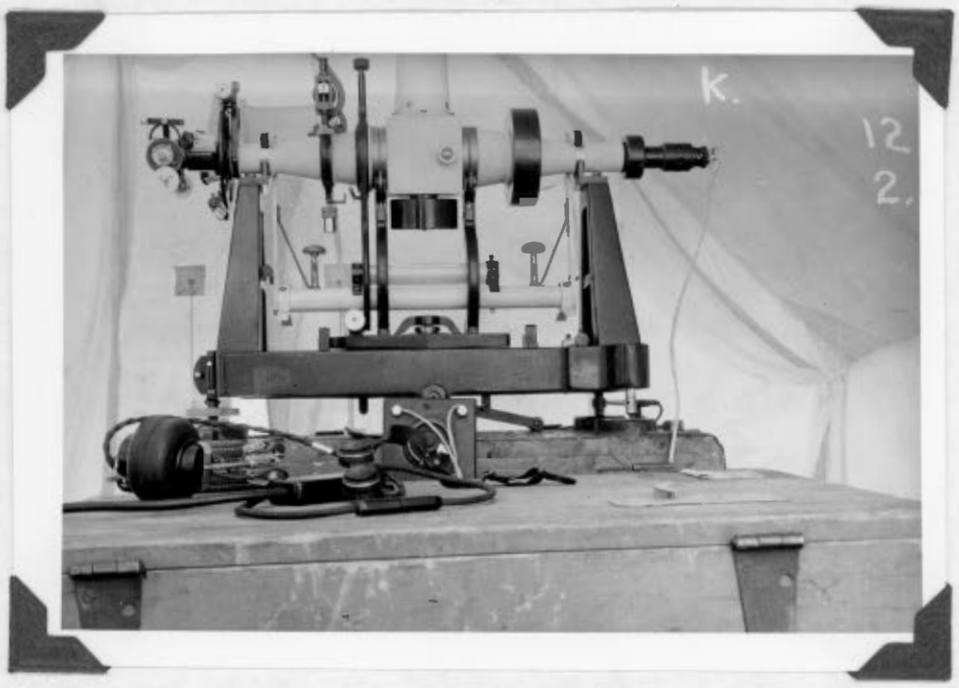
Winter observing in temperatures as low as -40° F. was a new experience to me and, although before leaving Ottawa we had tried to anticipate and prepare for all conditions which might arise, we did not completely succeed in finding a satisfactory solution to all the difficulties which later beset us in the field.

Let me commence by giving a list of the difficulties which we foresaw before leaving Ottawa, the preparations made to alleviate them, and the degree of success attained by these measures in the field.

Difficulty foreseen	Preparatory Measures taken	Degree of Success in Field, with further suggestions
(1) Thickening and hardening of grease and oil used to lubricate the instruments in the summer.	The instruments (1 Heyde, and 2 Wilds) were taken apart and all the old grease and oil cleaned out by Mr. W.M. Dennis. They were then lubricated with special winter lubrication, Shell V 6038. The knobs used to select the vertical or horizontal circle in the reading microscope of the Wilds were the only parts not winterized since it was not considered necessary to have these knobs working perfectly.	All parts of the instruments, except the 2 knobs on the Wilds which were not winterized, functioned just as smoothly as they ordinarily do in the summer. The knobs which were not winterized on the Wilds were extremely stiff, requiring most of the force of one hand to turn them. Except for sun azimuth observations, it was not necessary to turn these knobs during an observation, but certainly the force required to move them would be sufficient to affect the stability of the instruments.
(2) Frosting up of instruments from observer's breath at very low temperatures.	This difficulty was foreseen, but nothing could be thought of to prevent it except for the observer to be extremely careful in breathing. It was also thought that the frost would disappear quickly after forming.	This obstacle proved to be more troublesome even than was anticipated. The Wild theodolites, being used outside in the open, were not quite so troublesome as the Heyde, which was used inside an observing tent. In the daytime, especially with the sun out, no trouble was experienced with the Wilds unless the observer breathed directly on the

Difficulty foreseen	Preparatory Measures taken	Degree of Success in Field, with further suggestions
(2) continued		instrument, and even then the frost would disappear in about half a minute. However, at night, provided there was no breeze, the Wilds would frost up badly if the observer breathed even near the instrument at all, and it would take 2 or 3 minutes for the frost to disappear of its own accord. It was thus necessary to clean the eyepiece regularly, and even the objective, with alcohol. Cleaning the eyepiece was a problem when the 45° prism was attached. The Heyde, in the tent, frosted up simply from the observer's presence. Breath seemed to hang in the air and settle all over the instrument, necessitating cleaning with alcohol about every 4 or 5 minutes. To breathe directly on the eyepiece was disastrous, which meant holding one's breath while clocking a star. This was difficult for the slow moving polar stars. Opening the sides of the tent a little helped quite a bit, but too much breeze made observing too cold on the bare hands at -40° F. Frosting was extremely bad at -40°, becoming less and less of a problem at higher temperatures, and being almost insignificant at temperatures above zero. A suggestion which seems to offer good possibilities for removing frost from lenses would be to apply alcohol with a camel hair brush, and then dry the alcohol off with a jet of air from a rubber bulb. This method would leave no lint on lens and would put no force on instrument.

Difficulty foreseen	Preparatory Measures taken	Degree of Success in Field, with further Suggestions
(3) To find something to wear on hands that would not be too clumsy for observing, and yet keep hands reasonably warm.	Three types of hand-gear were supplied to be tried for this purpose - (a) Silk Gloves (b) Wool gloves with fingers cut off at second joint. (c) Wool wristlets with no fingers at all, but just a hole for the thumb, and a hole for the 4 fingers.	(a) The silk gloves were good for anti-contact action when touching metal, but provided virtually no protection against the cold itself. They were also too slippery for the delicate longitude work of following a star with the micrometer. (b) These gloves, of course, served no anti-contact purpose, but did keep the rest of the hand warm. However, they seemed to me too tight between the fingers and cut off some of the blood from the finger tips, causing the finger tips to be colder than they would have with no gloves. (c) This type of wristlet seemed to me to be most satisfactory. It served no anti-contact purpose, but tape or chamois can easily be used to cover metal knobs. The wristlet kept the whole hand warm except for the fingers, and by keeping a free flow of warm blood supplied to the fingers, it even contributed to their warmth. The three fingers not in use could be curled up inside the wristlet. This wristlet in company with covered instrument knobs seemed to me to be almost an acceptable solution. Of course, with any observing glove or wristlet in such cold it is necessary to insert hands into warm pockets or warm mitts when not in use.
(4) To keep clocks from getting too cold since they had not been winterized, and to keep radio and instrument batteries warm.	Since we were to be travelling by tractor train and cabooses, it was thought wise to keep the recorder, radios, all batteries except the instrument lighting batteries, and the recording	The telephone arrangement was ideal. The recorder and recording instruments were kept warm inside the heated caboose, and by virtue of the throat mike and earphones the observer could work unhampered in the tent. The cable



Heyde transit used for precise latitude and longitude determinations. Note the throat microphone and ear-phones on box in foreground.

Heyde transit in observing tent. The opening in the roof of the tent shows a little at top of picture.

Difficulty foreseen	Preparatory Measures taken	Degree of Success in Field, with further suggestions
(4) continued	instruments inside the caboose. Two field telephones were acquired from the Air Force to communicate between the observer in the tent and the recorder in the caboose. The observer's telephone was equipped with earphones and throat microphone to leave his hands free. A box was built to accommodate the observer's telephone and lighting batteries with a small kerosene heater to keep batteries warm. The box was insulated with felt and had the telephone on a top shelf with the heater and lighting batteries on bottom. A kerosene car heater was used.	connecting the observer's phones and mike to the telephone set did not cause any inconvenience at all. It was also convenient to have the recording instruments inside since the observer could warm himself while taking time signals and while making any adjustments to relays or other parts of the apparatus. The wires running from tent to caboose were fortunately rubber insulated since plastic insulation becomes unmanageably stiff at low temperatures. The heater and heater box worked admirably at -40° F, although it was advisable to leave the lid of the box slightly open to prevent the batteries getting too warm. A smaller heater would have been quite sufficient, but we could not find a smaller one commercially.
(5) To secure a level and solid pier for the Heyde instrument.	It was decided to employ two boxes which bolted together to form a pier for the Heyde. These boxes had been designed earlier by Mr. C.H.Ney to use with the Heyde on regular summer work. The boxes were intended to be filled with rocks or sand bags, bolted together, and then bolted on to angle iron pegs driven into the ground at the corners.	This arrangement worked very well with a few modifications. No rocks or sand were available, so about 150 lbs. of scrap iron was borrowed from Bond Construction Co. to weight the boxes. Securing a level spot for the base was a little difficult on the frozen ground, but with a little patience a level spot could be chipped off with the flat end of a pick. In one spot we froze water on the ground to give a level and flat spot. This worked very well. In the frozen ground it was impossible to drive the angle iron pegs straight, so that we could never match the holes in the angle iron with the holes in the box to bolt the box

Difficulty foreseen	Preparatory Measures taken	Degree of Success in Field, with further suggestions
(5) continued		to the pegs; however, the pegs seemed to draw in against the iron corners on the box with sufficient force to give a solid set-up. Wherever it was not possible to drive the pegs in, we froze the bottom of the box to the ground, obtaining a solid pier.
(6) Lengthening of vertical circle bubble on Wilds so that ends of bubble passed out of view in viewing prisms.	All of our Wilds were taken down to -20° F in the cold chambers of the National Research Council. Of these, only one had a bubble still readable. This instrument, No.551, remained readable down to -40° F.	Wild #551 was perfectly readable in the field to the lowest temperature of -40° F. in which it was used. Wild #506, bubble was not readable at temperatures below -20° F, and not satisfactory for temperatures below zero. #551 seems to be the only Wild we possess whose bubble is usable in sub-zero weather.

The preceding table describes the success we had in anticipating difficulties in low temperature observing. There were, however, one or two troubles we did not foresee.

(1) The cross-hairs in the micrometer eyepiece of the Heyde sagged so far at temperatures to 20° below zero or colder that it was impossible to use it. Fortunately, a spare eyepiece with tighter cross-hairs was carried and pressed into use. I was not able to decide for sure why the hairs should sag at low temperatures. It may have been because of the contraction of the metal frame holding the cross-hairs, or it may have been because of condensing moisture in the air. I did not anticipate moisture in the cross-hairs because of the air being so dry, but it is possible that the relative humidity of the air around the observer and instrument was so high that the cross-hairs were able to become quite damp. At any rate any one

working with cross-hairs at low temperatures should be sure that they are tightly stretched.

(2) Station Mark

Digging of the six-foot circular trench in the frozen ground was more difficult than anticipated because of the large moisture content in the ground before freezing. Picks and shovels were used and seemed to be as satisfactory as any tools, although sometimes an axe was handy for widening the trench, smoothing the edges and chopping through roots. Building a fire over the ground to be dug to thaw it out helped the digging, but I believe it was more trouble than it was worth.

WINTER CLOTHING REPORT

1950

W.D. FORRESTER

GEODETIC SURVEY OF CANADA

REPORT AND SUGGESTIONS ON WINTER CLOTHING USED ON 60TH PARALLEL, 1950

The winter clothing issued to the three members of the Geodetic Survey for this operation was found to be quite adequate, although in some cases slight alterations might have enhanced their usefulness.

Footgear

We were issued with only one type of footgear, namely army-type canvas mukluks with heavy rubber soles to be worn with double duffle socks, wool socks and insoles. This footgear was slightly heavy and clumsy, but extremely warm. For sitting around observing outside at sub-zero temperatures they were perfect. However, for walking any distance they were too clumsy and really too warm for the feet. Also, since it was found too awkward to wear these mukluks with snowshoes, moccasins of moose hide were purchased from Indians for this purpose. It was found that if the moccasins were large enough to accommodate 1 pair of wool socks, 1 pair of single duffle, and 1 pair of felt insoles, they were then ideal for wear with snowshoes. The insoles served to keep the ridge on the snowshoe from hurting the ball of the foot, and the single duffle was warm enough, but not too warm for walking.

We found that the ground becomes quite wet and muddy long before there is any real danger of being caught by the spring break-up, so that for the last 3 weeks of the operation we felt the need of a more waterproof footgear. The mukluks had rubber soles, but the snow was wet enough to soak the canvas tops. Also, the mukluks were much too hot for wear in this early spring weather. We found rubber bottomed, leather top boots with heavy socks and insoles most satisfactory for this sloppy season. To be completely equipped,

I believe an observer should carry all three types of footgear, although if no observing were to be done, the mukluks might possibly be dispensed with.

Lower Body Clothing

We were supplied with one piece of heavy woollen underwear, Melton cloth ski pants, windproof trousers, and fleece-lined sheep-skin flying pants as were issued during the war to the U.S. Army Air Force.

The windproof trousers were never used since the Melton cloth ski pants seemed to be windproof enough, although we never encountered any really strong winds during the coldest weather. If one was exercising at all, the underwear and ski pants were quite warm enough at -40° F, which temperatures were the coldest we encountered. The outer pants must not be tight enough to cling to the legs, however, if they are to give the most warmth. The secret for obtaining the best results from any winter clothing is to not have it fit too tightly, since air spaces provide wonderful insulation. The clothing does not need to be sloppy, of course, to achieve this. The ski pants were very convenient for tucking into the mukluks and high top boots.

For sitting down to observe with the Heyde, I found that at -30° F or -40° F the fleece-lined pants worn just over the underwear were very satisfactory. They provided enough insulation to sit on, and kept the legs quite warm. It is very important to have the body comfortably warm when observing, as one is then more relaxed and can do a better job. These fleece-lined pants were too warm and clumsy for a job involving much exercise, but were ideal for observing.

A warm type of athletic support was found to be a necessity, especially if one was going to be walking or standing around on a cold windy day.

Upper Body Clothing

We were supplied with an army parka and hood with detachable wool pile lining, wool shirts, a woollen windbreaker, a woollen muffler, and a string vest, as well as the woollen underwear previously mentioned. The parka was very satisfactory, being windproof and warm to the lowest temperatures encountered. I might suggest that slash pockets with pile lining would have been very convenient in the parka for our use since they would have offered a place to warm one's hands easily between observations. The unlined side pockets the parka was equipped with were of no use for warming hands. The parka was too warm for very strenuous exercise such as snowshoeing over an unbroken trail even at quite low temperatures of 20 to 30 below zero.

The windbreaker with a wool shirt and underwear underneath was found to be quite warm enough for wear while exercising. The string vest did not get much use by us since it is designed to be worn next to the skin, and it was found to be too tight under the woollen underwear issued to us. The string vest should be used under looser underwear made of pyjama cloth, but we were unable to obtain this type of underwear. The idea of the vest is to provide an air gap between the body and the underwear, both to act as an insulator, and to prevent the underwear from getting damp from perspiration during exertion. Clothing that becomes damp from perspiration chills one as it dries out later. I understand that these string vests serve the purpose indicated quite well, but for the reason stated above we were unable to give them a fair test. However, the woollen underwear supplied to us was certainly found to be warm enough, although it did get quite damp from perspiration at times.

Headgear

We were issued with army balaclava helmets and army peak caps with ear flaps. We never found occasion to use the balaclavas since the face seems to be able to stand quite a bit of cold, and since balaclavas seemed uncomfortable both because they frosted up from the breath, and because one seems too hemmed in while wearing one. The peak cap was, as far as I was concerned at least, of use only for keeping the hair out of one's eyes while observing, and even for that purpose it had to be worn backwards to keep the peak from bumping the instrument. The ear flaps were just made of cloth and had to be fastened down with two ribbons tied under one's chin to keep the ears warm at all. I preferred to wear the ear flaps up and to use ordinary ear muffs to keep my ears warm. To make the cap suitable would simply require equipping it with fur ear flaps. For our purpose it would be better to have no peak on the cap to facilitate instrument work. The peak does not seem to serve any great purpose since it is too small to effectively shade one's eyes.

Sun glasses were supplied to us and are essential on the bright days to offset snow glare. The polaroid glasses we had seemed to be as good as any. They had plastic frames and plastic polaroid screens.

Handgear

For this purpose we were supplied with woollen mitts, leather outer mitts to wear over the woollen mitts, cotton work gloves, and fleece-lined leather mitts.

The combination of the woollen liner mitts, and the leather outer mitts was warm for the lowest temperatures encountered. Here again, the important thing is to have your mitts to fit not too tightly. It is especially important to pick a mitt that does not fit tightly on the thumb, as it is

usually the thumb that gets cold first in a mitt.

The cotton work gloves were convenient for jobs such as chopping wood and digging marker trenches, where the heavier mitts were a little too awkward. For most jobs that these gloves were used for, the exertion was sufficient to keep the hands reasonably warm inside the gloves, at least for temperatures to 10° or 20° below zero. It was necessary to keep the gloves clean from grease or oil though, as oily gloves offer little protection from the cold.

The fleece-lined mitts served much the same purpose as the leather mitts with liners, but were used in the spring when the heavier mitts were a little too warm.

For a discussion of handgear for use while observing, see report on "Difficulties Encountered in Winter Observations along 60th Parallel of Latitude."

General Notes on Winter Clothing

In choosing winter clothing it is wise to keep two main points in mind.

(1) Be sure that all articles of clothing do not fit too tightly. This is especially important in choosing footgear and handgear.

(2) Try to choose an outfit of clothing that can be worn in different combinations to cover the different conditions under which you will be working. For example, we found for very cold observing it was necessary to wear heavy underwear, woollen shirts, sheep-skin pants, parka with lining, heavy socks, double duffle socks, and mukluks. For manual work, however, a windbreaker replaced the parka, ski pants replaced the sheep-skin pants, and high cut boots replaced the mukluks. For warmer days, it was often necessary to take off the windbreaker to work. There

is a danger with the present availability of such things as fleece-lined coveralls, vapor barrier suits, etc., that one might feel prepared so long as he is equipped for the coldest weather he will encounter, while his outfit is not flexible enough to provide for all the varied conditions he will be subjected to.

(W.D. Forrester)

Report on Winter Transport Suitable for Completion of Alta. - N.W.T. Boundary Work in Light of 1949-50 Experience.

In a consideration aimed at choosing the most practical means of transportation for any undertaking it is necessary to take into account four main factors:

(1) type of country to be covered

(2) type of work to be done and type of equipment to be carried

(3) expenditure in time

(4) expenditure in money

We shall now try to deal with all methods of winter transport conceivable for the astronomic location of the Alta.-N.W.T. boundary keeping the above four factors in mind. Travel by ski-equipped aircraft, dog team, packhorse train and tractor train are all worthy of our attention in this report. We should keep in mind that the country to be traversed is quite rugged, contains several lakes suitable for winter aircraft landings, and has a bulldozed trail along all but 20 miles of the border area we are concerned with.

The use of a ski-equipped aircraft by itself seems to be ruled out by the unlikelihood of being able to find lakes that are suitable to land on and that would still satisfy the conditions of placing the astronomic stations all 25 miles apart and within 20 chains of the boundary. Such an aircraft could, however, work quite successfully as a means of supply in conjunction with dog teams or pack horses. I believe the cost of hiring such an aircraft by the mile is about 75¢ per mile.

The use of dog teams on this operation would be possible and would probably be the least expensive method with the exception of air transport, which, I believe, is ruled out. The time that would be consumed by dog team transport would be about the same as that consumed by pack horses or tractor train. The weight and bulk of zenith telescope, theodolite, radios, batteries, chronometers, chronograph, books, tents, stoves and supplies would likely require at least 4 or 5 dog teams at a rough cost of 12 or 15 dollars per team per day. With cost of food and a cook added to this, I am sure the price per day could not be less than 100 dollars. Dog teams can follow a snowshoe trail, so that there is no doubt the

party could move freely to any spot it chose for a station. However, the use of dog teams would mean that the party would be housed in tents and would have to find means of meeting problems of frozen batteries, frozen chronograph ink, and inaccuracies in chronometer rates caused by wide changes in temperature. Some time would also be lost because of the need to set up and fold camp between each day's travel, and to clear a station site about 50 feet square by axe at each observation point.

Pack horse trains do not seem to be as feasible as dog teams since they have all the drawbacks of dog teams, but lack some of the advantages. The party would still be housed in tents with the above-mentioned difficulties, and the expense in time and money would be about the same as for dog teams; however, horses would probably have more difficulty in making their way through the three feet deep snow than the dog teams would. Since most of the trail was bulldozed last winter by the Topographic Survey, the horses would only have 20 miles of actual bush trail to cover plus whatever side trails had to be made into chosen station sites. However, horses would possibly find difficulty moving with packs through this uncut part of the trail, especially with the snow and 60 degree below zero weather to add to their misery. It would probably be necessary to have a pack train supplied periodically by air to avoid carrying too much feed for the horses. With pack horses, as with dogs, a camp would have to be set up and then broken between each day's travel and station clearings would have to be made by hand, with evident losses in time.

Of tractor trains I am able to speak from recent first hand experience. The advantage that they afford are warm living quarters, an easy method of keeping batteries, chronometers, and ink at a warm and fairly constant temperature inside the cabooses, and a simple and quick means of clearing a station site (the bulldozer can clean a station site right down to the bare ground in 5 or 10 minutes). Also with a tractor train, the kitchen and living quarters are

more permanent and do not need to be set up and torn down every day. A tractor train could proceed over the trail cleared last year by the Topographic Survey and make its own trail for the last 20 miles with one bulldozer, one fuel sleigh, and two cabooses. The complete cost of this, including food and board would probably run between 150 and 200 dollars per day running time, and about 100 dollars per day stand-by time. Tractor trains can make about 2 m.p.h., so it would take 2 eight-hour days running time between stations. The length of time consumed by tractor train would be about the same as by dog team or pack horse, but might possibly be slightly less. In the winter of 1949-50 the Geodetic Survey was able to complete four stations in one month, making its own road as it went with a bulldozer and tractor train. However, in the previous month, three weeks time was lost when the tractor sank into an unfrozen sulphur bog. Such accidents as just mentioned are not very likely on the more rugged road to the west of the Grimshaw Highway, but accidents of other nature must be at least recognized as possible. In a tractor train, the astronomical instruments and radios are treated to quite a rough ride, but it is not hard to pack them to stand this.

To sum up the case for and against the tractor train we may say that

(a) they are much more convenient for the observing party than any other transport,

(b) they are as fast as or faster than any other transport for completing the job, unless they are subjected to a serious breakdown,

(c) it has been proven by the Topographic Survey last year that tractor trains can definitely cover this particular bit of terrain,

and (d) they are more expensive than any of the other types of transport.

It is my personal opinion that a tractor train would be the best method of tackling the remainder of this job. It should be made certain that the tractor supplied is in first class condition, as a good tractor would stand very little chance of serious breakdown, whereas a tractor in poor condition would be

almost certain to have trouble over this rough country. I believe that the tractor train has many more operating advantages than the other methods of transport, but it must be conceded that its expense would be greater than that of the others. In arriving at a decision, convenience must be weighed against expense, and I hope that this brief report will offer some assistance in reaching a conclusion.

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