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TEMPERATURES AND INTERVAL GEOTHERMAL-GRADIENT DETERMINATIONS FROM WELLS IN NATIONAL PETROLEUM RESERVE IN ALASKA

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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GEOTHERMAL GRADIENT DETERMINATIONS FROM WELLS IN NATIONAL PETROLEUM RESERVE IN ALASKA

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ABSTRACT

Temperature and related records from 28 wells in the National Petroleum Reserve in Alaska (NPRA) although somewhat constrained from accuracy by data gathering methods, extrapolate to undisturbed formation temperatures at specific depths below permafrost, and lead to calculated geothermal gradients between these depths. Tabulation of the results show that extrapolated undisturbed temperatures range from a minimum of 98oF (37oC) at 4,000 feet (1,220 m) to a maximum of 420oF(216oC) at 20,260 feet (6,177 m) and that geothermal gradients range from 0.34oF/100' (6oC/km) between 4,470 feet to 7,975 feet (Lisburne #1) and 3.15oF/100' (57oC/km) between 6,830 feet to 7,940 feet (Drew Point #1). Essential information needed for extrapolations consists of: time-sequential "bottom-hole" temperatures during wire-line logging of intermediate and deep intervals of the bore hole; the times that circulating drilling fluids had disturbed the formations; and the subsequent times that non-circulating drilling fluids had been in contact with the formation. In several wells presumed near direct measures of rock temperatures recorded from formation fluids recovered by drill stem tests (DST) across thin (approx. 10-20 foot) intervals are made available.

We believe that the results approach actual values close enough to serve as approximations of the thermal regimes in appropriate future investigations. Continuous temperature logs obtained at the start and end of final logging operations, conductivity measurements, and relatively long-term measurements of the recovery from disturbance at shallow depths in many of the wells will permit refinements of our values and provide determination of temperatures at other depths.

INTRODUCTION

Current exploration of N.P.R.A. (Figure 1) included significant investigation of the present day geothermal regimes to provide data on permafrost and for sensing the thermal history of the rocks. Ordinary well drilling procedures yielded temperature records from which undisturbed formation temperatures and interval geothermal gradients have been derived. Extraordinary continuous-temperature logs, long-term measurements in abadon-wells, and rock conductivities will enable refinement of these preliminary thermal determinations. These results will then allow more definitive investigations directed to studies concerned with the regional heat flow and the generation of hydrocarbons from organic source material.

Temperature data and extrapolations from 28 wells drilled during the 1974-1981 period under the auspices of the U.S. Navy and the U.S. Geological Survey are presented. Also, available temperature measurements from nine of the older Navy wells are presented, however, pertinent data necessary for reasonably accurate calculation of undisturbed temperatures were not recorded, therefore, these data are considerably less reliable. No attempt was made to determine temperatures in the Barrow area as these wells reach basement at approximately 2,500 feet (±) and bottom hole temperature measurements from these wells are "too low to read", due partly to the influence of permafrost.

A previous attempt (Blanchard and Tailleur, 1981) was made to characterize the thermal regime of N.P.R.A. by contouring the geothermal gradients from 22 wells in and a few wells outside the Reserve. Some of the gradient determinations have been revised and recalculated in this paper.

DATA GATHERING

The practice of logging wells prior to setting strings of casing results in numerous sets of successive bottom-hole temperatures (BHT). These measures of progressive change in temperature can extrapolate to the temperature of the rock before being distubed by drilling. The quality of the temperature and related time records determine the accuracy of the results. Appreciation of the undisturbed-disturbed temperature relationships and of the kind and source of data limitations, requires a fair understanding of drilling and logging procedures. Wells are usually drilled in two or more stages and provide sets of BHTs near the end of each. The sequence is to drill an appropriate depth, stop circulation of the drilling fluid after the cuttings have been brought to the surface and the hole conditioned, run the drill string out of the hole, log with successive runs of different instruments or tools on a wire-line (hole conditions may require re-entry and circulation between runs), and case the hole if another stage of drilling will follow. We found that use of the BHT and log records required considerably more discretion than is usually implied in the literature on geothermal conditions derived from similar data. Although attainable at insignificant added expenditure, precise and accurate data are not commanded by the main objectives of logging; it seems in practice that, opportunity for numerous reliable determinations of a rock attribute, essential to exploration, is foregone.

Penetration by the bit begins disturbance of the rock temperature at any drilled depth. Exchange of heat between the drilling fluid and wall rock will proceed until circulation stops. Then the mud temperature will move towards

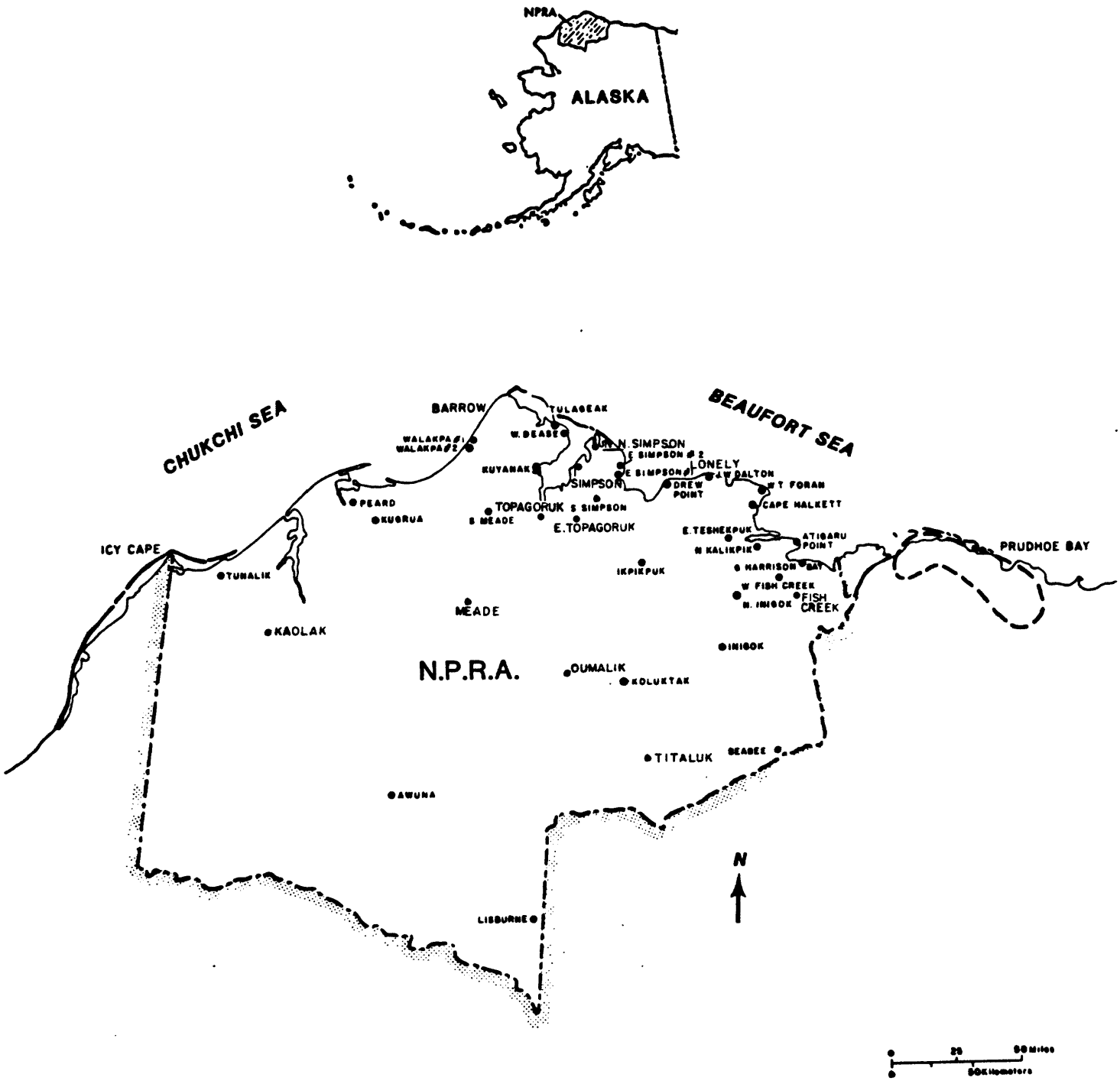

Figure 1. Map of N.P.R.A. showing location of wells discussed in text (excluding Barrow wells).

the undisturbed temperature of the wall rock. The last surface drilled, before logging at the bottom of the hole, is disturbed only during the relatively short period of circulation after drilling ceases. Therefore, the mud temperatures at the bottom of the fluid column will approach the undisturbed temperature most rapidly after circulation stops.

The so-called bottom-hole temperatures actually record the maximum temperatures encountered on each run down the column of static drilling fluid to a variable and undeterminable depth above drilled bottom. Imprecision in depths of measurement result from: 1. fixing of the maximum-reading thermometer to the wire-line at a convenient distance above the logging tool; 2. variable lengths of single and combined logging tools; and 3. slough or other obstruction that keeps the bottom of the tool off drilled bottom. For our calculations the average length of the logging tool was considered to be 50 feet, and this number is subtracted from the depth recorded to which the logging tool reached. The only exceptions are the temperatures from the dual continuous temperature logs which are at total depth reached by the tool. This depth is usually T.D. (total depth), however, due to caving, backfilling, swelling, or other hole problems the tool does not always reach drilled total depth.

Imprecision in the depths of the BHTs critically affects extrapolations because the method hinges on the time-dependent temperature changes after the fluid stopped circulating past a specific depth. Because disturbance increases uphole, the rate of adjustment between drilling fluid and wall rock differs at different depths above bottom. In addition and for reasons we have not determined the lower few hundred feet of continuous temperature logs can show high frequency with significant amplitude variations persistently as well as initially. From the continuous dual temperature logs (Figure 2) it is clear that exact knowledge of where in the hole maximum temperatures are recorded is critical, and movement up or down the section of a hole of ten feet could record a change of several degrees (oF) in the mud temperature. This is undoubtedly one reason for the departure of some temperature readings from the linear cooling or warming relationship of mud temperatures (Figure 3).

Time is also a factor critical to extrapolation. Accuracy of derived values depends importantly on the length of time circulating fluids have disturbed the formation at a given depth as well as on the time lapsed between temperature measurements and the time since circulation stopped. This given depth we chose to be 50 feet above the depth to which the logging tool reached and the circulation time in this interval must be reconstructed from the mud log drilling rate curve and the driller's records.

By design, the wire-line loggers record the time, or time since circulation stopped, the time each logging tool reached bottom, and the maximum temperatures on the heading of each log. Two additional pieces of information usually not recorded on the log heading but considered essential for accurate extrapolations are the noting of any recirculation of the drilling fluid during the logging operations and noting the distance at which the maximum recording thermometer is affixed from the bottom of the logging tool. Inconsistencies in the heading information will indicate erroneous or fabricated information, some of which can be resolved by comparison to the various drilling logs and histories of drilling operations.

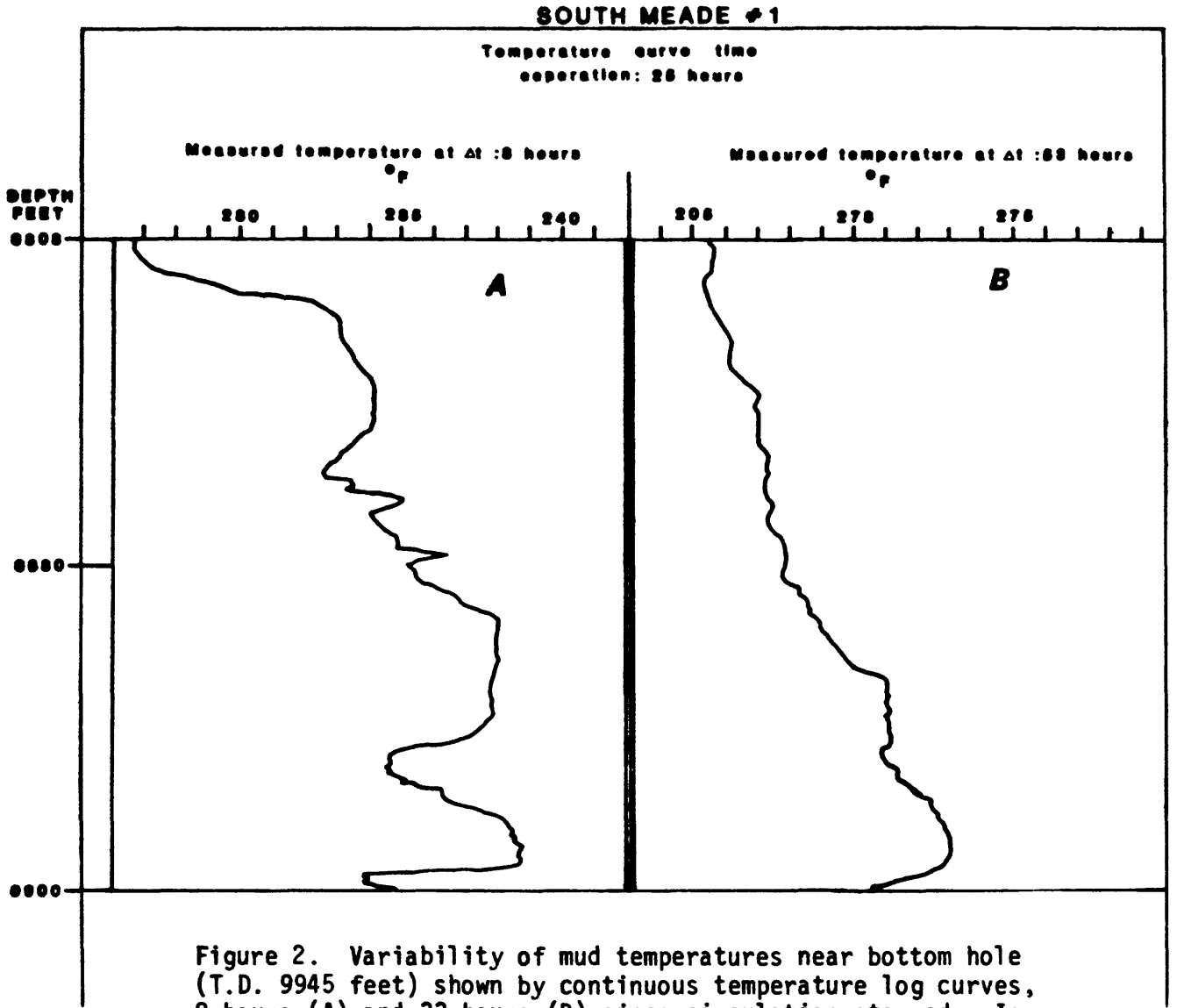

Figure 2. Variability of mud temperatures near bottom hole (T.D. 9945 feet) shown by continuous temperature log curves, 8 hours (A) and 33 hours (B) since circulation stopped. In B, temperature variations smooth considerably and reflect the progressive warming of the static mud column towards the undisturbed temperatures of the wall rock.

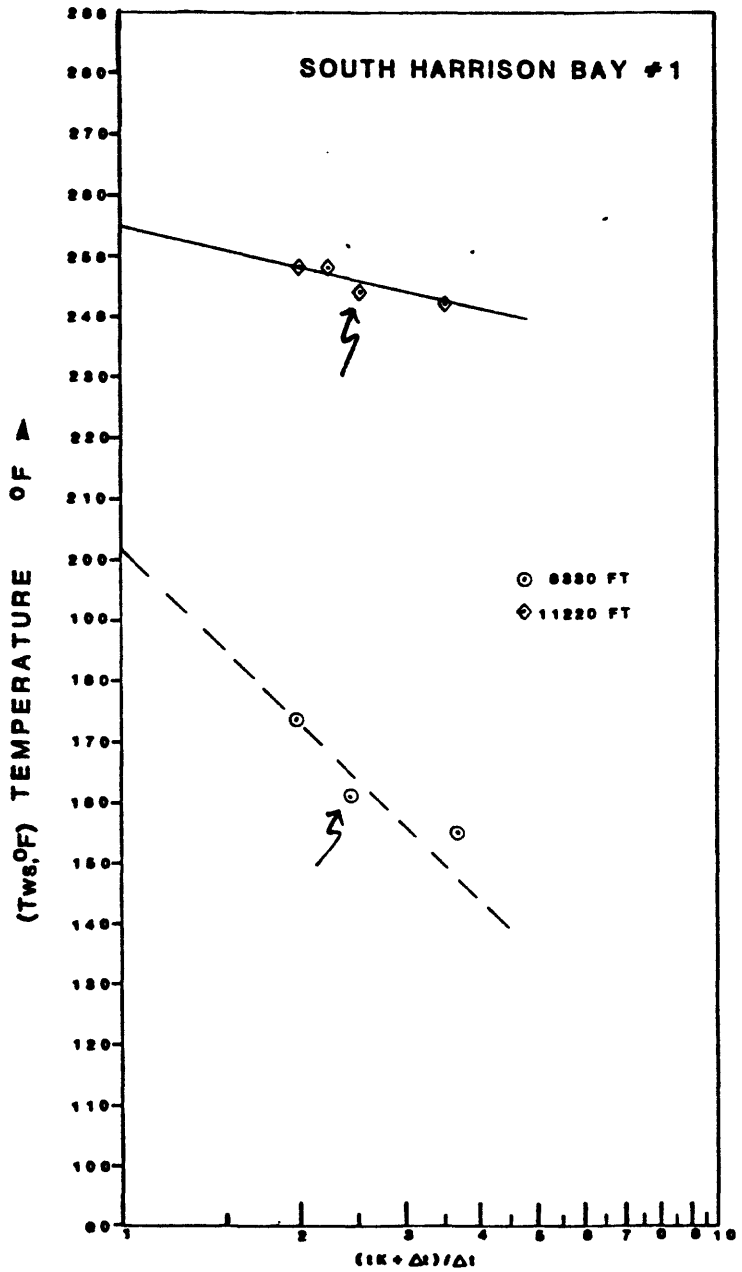

Figure 3. Arrows point out possible deviations from the linear warming or cooling relationship of maximum temperatures. This is probably due to the variable depth in the hole at which temperatures were recorded.

The logging of shallow intervals did not produce information suitable for extrapolation. The maximum recording thermometers do not measure the drilling mud temperature at the bottom hole, which is significantly cooled by the influence of permafrost. Instead, the warmest temperature the thermometer records is from the very top portion of the mud column which is relatively warm due to the insolation of the surface casing (at 100 feet ±) and the enclosed heated rig housing. Often, even these temperatures are below the minimum temperature capability of the thermometer and are marked on the log heading as "too low to read".

METHOD OF EXTRAPOLATION

The method used to obtain "bottom hole" undisturbed temperatures is based on the Horner Plot principle modified by Dowdle and Cobb (1975). Although not mathematically correct, this modified plot has been shown by Dowdle and Cobb, to give reliable estimates in regions of "high geothermal gradients" and shorter circulating times, specifically in the Gulf Coast area. They modified the Horner Plot to graph the bottom hole undisturbed temperature (static temperature of Dowdle and Cobb) as a function of the circulating time (t_K) plus the time since circulation stopped (Δt) divided by the time since circulation stopped (Δt), $\left(\frac{t_K+\Delta t}{\Delta t}\right)$, plotted logarithmically on the x-axis versus the actual mud temperature recorded plotted on a linear scale on the y-axis Tws, ^{o}F . This relationship can be expressed in the equation $\theta(\Delta t) = \theta\infty + s\log\left(\frac{t_K+\Delta t}{\Delta t}\right)$, (Lachenbruch and Brewer, 1959) where $\theta(\Delta t)$ = temperature as a function of time since circulation stopped; $\theta\infty$ = undisturbed temperature; and s is a constant which may be different for each depth. Such calculation requires knowledge of the depth in the borehole at which temperatures were recorded, the duration of the disturbance at that depth (t_K), the durations (Δt) of times since circulation stopped, and the actual recorded maximum temperatures at those times.

When graphing the data, we modified Dowdle and Cobbs technique slightly for wells with reasonably good data. Since a short circulating time (t_K) and a longer time of non-circulation (Δt) will give the most reliable temperature estimates, our line of extrapolation is biased towards the small $\left(\frac{t_K+\Delta t}{\Delta t}\right)$ points. For an example see Figure 4, at the 8,100 foot depth.

FORMATION FLUID TEMPERATURES

In this report available drill stem test (DST) temperatures from 25 of the recent wells (1974-1981) are in Table 3 (including temperatures from the Barrow area 1964-1981 (Figure 5) but excluding those published by Collins, 1961, from the old Navy wells). Formation fluid temperatures recorded during DSTs probably approach undisturbed formation temperatures very closely; if fluids recovered come from beyond the zone of thermal disturbance. The drill stem test tool is designed to draw formation fluid into a chamber when the retaining hydrostatic pressure head is removed and geopressures at depth

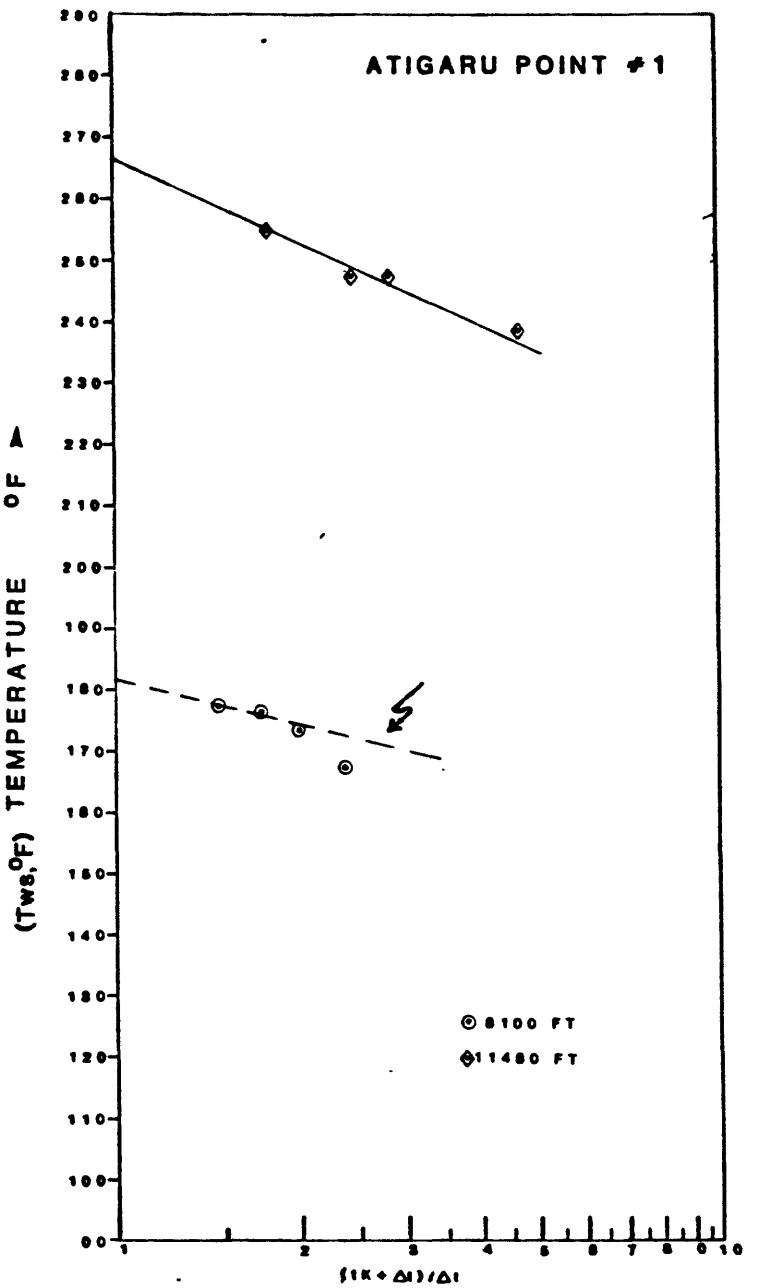

Figure 4. Linear extrapolations through data points to undisturbed temperatures are bias toward the small $(\frac{tk + \Delta t}{\Delta t})$ points, i.e. those points which are closer to equilibrium.

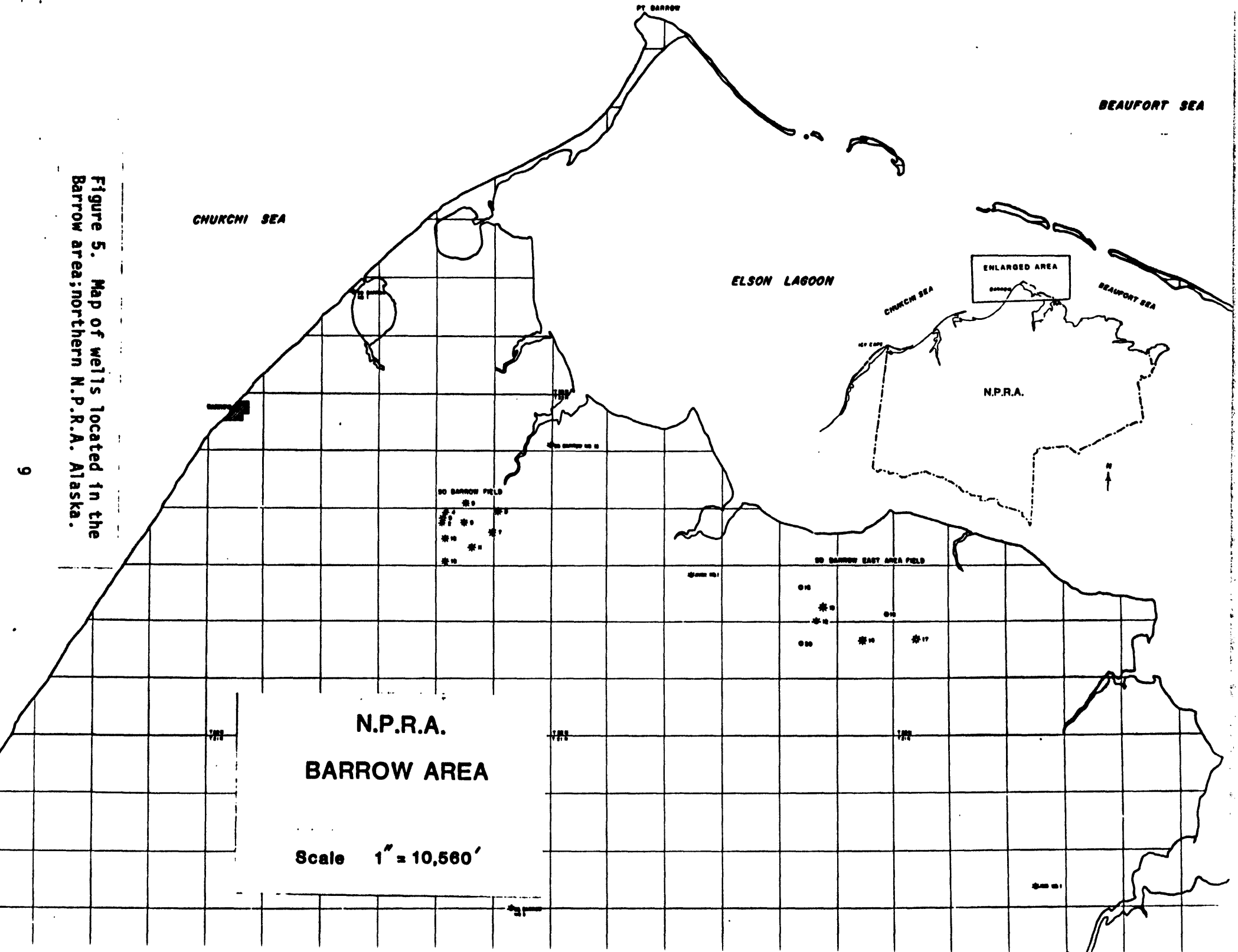

Figure 5. Map of wells located in the Barrow area; northern N.P.R.A. Alaska.

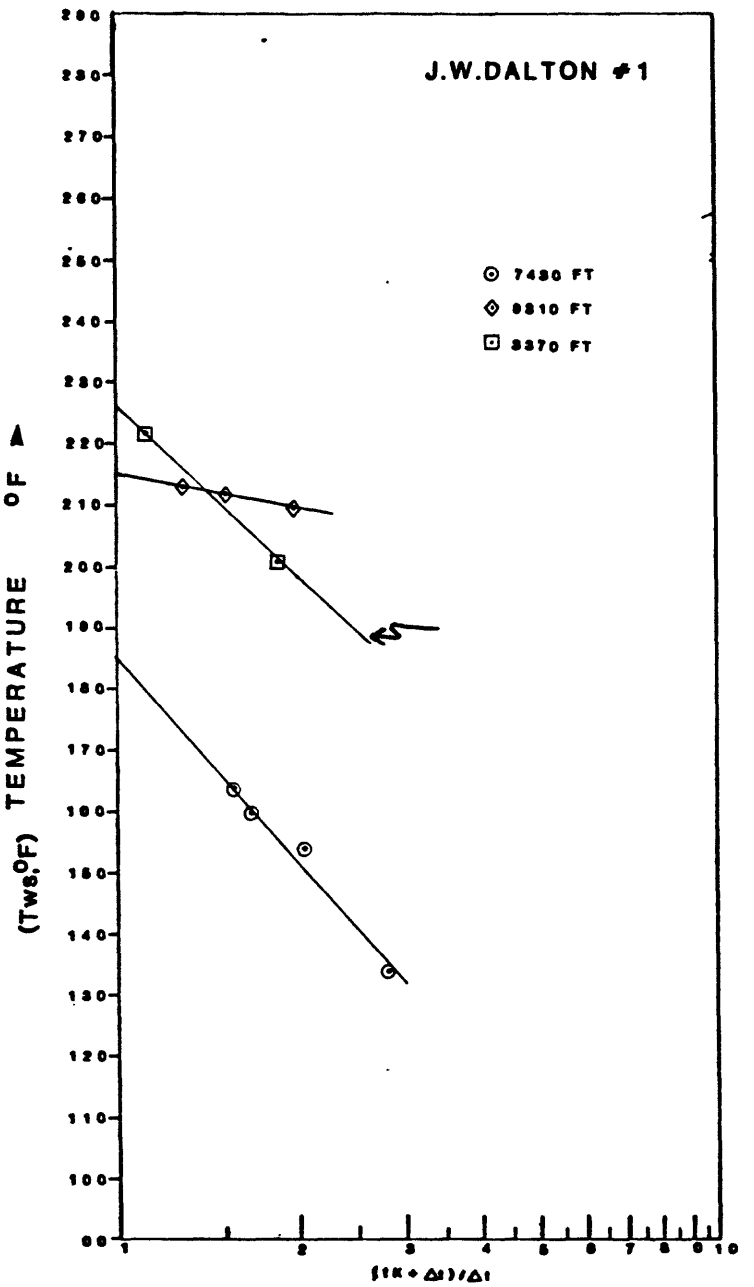

Figure 6. In the J. W. Dalton #1 well maximum bottom hole temperatures from the dual temperature log runs are plotted. At this depth, 9,370, a small disturbance time (6 hours) and large time since circulation stopped (7 hours for the 1st run and 55 hours for the 2nd run) enables extrapolation of the points 1·86 and 1·11 $\left(\frac{tk + \Delta t}{\Delta t}\right)$ to equilibrium temperature of 227°F.

equalize. Occasionally thermometer failure and temperatures beyond the thermometer range occur and are usually marked as estimates (est.) by the logging personnel. These are often significantly less reliable. These DST temperatures may be used as a comparison with geotemperatures derived by the extrapolation method. Additional wells in N.P.R.A. were tested but not listed in Table 3 because no formation fluids were recovered.

DUAL TEMPERATURE LOGS

In this report dual temperature logs have not been utilized to their full potential. The only data used from these logs are the maximum bottom hole temperatures. These logs record continuous mud temperatures from the surface ($\approx$100 feet) to total logged depth and provide an unbroken record reflecting the warming of the mud column with depth. The two temperature logs, run at the beginning and at the completion of logging operations, show the time-dependent temperature change at given depths. The separation of the two time-temperature curves is the initial reflection of the progressive warming or cooling of the mud as it begins to approach the undisturbed geothermal gradient (see Figure 2). The point at which the two temperature curves intersect will remain relatively constant as $t \rightarrow \infty$ (time approaches infinity).

Where available, the two bottom hole maximum temperatures are, when at the same depth, used to extrapolate to undisturbed temperatures and favored over the temperatures recorded during other log type runs. The primary reason for this is that the temperature probe reaches closer to the bottom of the hole than other log types, resulting in a small (t_k) and a large (Δt) at the second temperature measurement (see Figure 6). This, in effect, reflects a small disturbance time (t_k) and a longer time period since circulation stopped (Δt).

Dual temperature logs are available from the following wells: Awuna #1, South Barrow #16, J. W. Dalton #1, Drew Point #1, West Dease #1, Ikpikpuk #1, North Inigok #1, Koluktak #1, Kuyanak #1, Lisburne #1, South Meade #1, Peard Bay #1, East Simpson #1, East Simpson #2, Tulageak #1, Tunalik #1, Walakpa #1, and Walakpa #2.

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Dowdle, W. L., and Cobb, W. M., 1975, Static Formation Temperature From Well Logs--An Empirical Method: Jour. of Petrol. Tech. Nov. p. 1326-1330.

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List of symbols used in text and figures

t_k	circulating time (hours)
Δt	shut-in time (time since circulation stopped)
T_{ws}, °F	maximum recorded temperature
$\theta(\Delta t)$	temperature at shut-in time (°F)
θ_{∞}	temperature extrapolated to infinity (equilibrium) (°F)

UNDISTURBED TEMPERATURES AND GEOTHERMAL INTERVAL GRADIENTS FROM WELLS IN N.P.R.A.

Table 1

WELL	DEPTH	EXTRAPOLATED UNDISTURBED TEMPERATURE °C	°F	INTERVAL GRADIENT °C/km	°F/100'	FORMATION
Atigaru #1	8,100	84	183	-	-	Kingak
	11,480	131	268	46	2.51	Argillite
Awuna #1	5,240	52	125	-	-	Lower Torok/Fortress Mtn.
	8,255	60	** 140	-	-	Lower Torok/Fortress Mtn.
	11,140	105	222	30	1.64	Lower Torok/Fortress Mtn.
J. W. Dalton #1	7,680	85	185	-	-	"Pebble Shale"
	9,310	102	216	-	-	Argillite
	9,370	108	227	40	2.22	Argillite
West Dease #1	4,115	42	108	-	-	Argillite
Drew Point #1	6,830	77	170	-	-	"Pebble Shale"
	7,900	91	196	-	-	Argillite
	7,940	97	206	57	3.15	Argillite
Cape Halkett #1	7,820	79	174	-	-	Sag River
	9,850	99	210	32	1.77	Basement Complex
West Fish Creek #1	9,020	96	205	-	-	Kingak
W. T. Foran #1	7,540	80	176	-	-	"Pebble Shale"
	8,820	95	203	38	2.11	Lisburne
South Harrison Bay #1	8,330	94	202	-	-	Kingak
	11,220	124	256	34	1.87	Lisburne
Ikpikpuk #1	9,860	97	207	-	-	Sag River
	14,160	142	288	34	1.88	Lisburne
	15,340	149	** 300 +	-	-	Basement Complex
Inigok #1	8,260	74	165	-	-	
	*15,900	159	318	36	2.00	Lisburne Group
	*17,300	173	343	32	1.79	Lisburne Group
	19,200	187	368	24	1.32	Kekiktuk
	20,040	194	382	30	1.67	Kekiktuk

** Estimated from temperature log
* Circulation time in the hundreds of hours

UNDISTURBED TEMPERATURES AND GEOTHERMAL INTERVAL GRADIENTS FROM WELLS IN N.P.R.A.

Table 1 cont.

WELL	DEPTH	EXTRAPOLATED UNDISTURBED TEMPERATURE °C	°F	INTERVAL GRADIENT °C/km	°F/100'	FORMATION
North Inigok #1	8,430	106	222	-	-	Kingak
	10,120	124	255	35	1.95	Shublik
North Kalikpik #1	7,350	102	216	-	-	Kingak
Koluktak #1	5,825	62	144	-	-	Torok
Kugrua #1	8,650	85	185	-	-	Kingak
	12,540	127	260	35	1.93	Lisburne
Kuyanak #1	4,700	48	120:	-	-	"Pebble Shale"
	6,630	63	146	-	-	Argillite
	6,685	71	159:	36	1.96	Argillite
Lisburne #1	1,406	41	106	-	-	Okpikruak
	4,470	50	122	9	.52	Fortress Mtn.
	7,975	57	134	6	.34	Lisburne
	13,600	91	196	20	1.10	Lisburne
	16,955	121	250	29	1.59	Lisburne
South Meade #1	8,000	120	248:	-	-	Simpson S.S.
	9,900	154	309	-	-	Argillite
	9,945	145	297:	46	2.53	Argillite
Peard Bay #1	8,550	84	183:	-	-	Shublik
	10,180	109	228	-	-	Basement Complex
	10,220	110	231:	52	2.85	Basement Complex
Seabee #1	6,470	49	121	-	-	Torok
	9,930	82	180	31	1.71	Lower Torok/Fortress Mtn.
	12,730	108	227	31	1.68	Lower Torok/Fortress Mtn.
East Simpson #1	7,130	79	175	-	-	Shublik
	7,700	83	180	47	2.62	Basement Complex
	7,740	89	191	-	-	Basement Complex
East Simpson #2	6,380	68	155	-	-	"Pebble Shale"
	7,140	78	173	43	2.37	Shublik
	7,460	84	183	-	-	Argillite

Table 1 cont.

UNDISTURBED TEMPERATURES AND GEOTHERMAL INTERVAL GRADIENTS FROM WELLS IN N.P.R.A.

WELL	DEPTH	EXTRAPOLATED UNDISTURBED TEMPERATURE °C	°F	INTERVAL GRADIENT °C/km	°F/100'	FORMATION
South Simpson #1	7,150 8,750	78 103	173 218	- 51	- 2.81	Simpson S.S. Argillite
East Teshekpuk #1	8,280 10,610	102 141	215 286	- 56	- 3.05	Kingak Lisburne
Tulageak #1	4,000	37	98	-	-	Argillite
Tunalik #1	8,250 12,340 14,670 18,230 20,260	71 116 177 191 216	160: * 240 * 350 376: 420 +	- - - 39 -	- - - 2.16 -	Torok Kingak Shublik Lisburne Group Kekiktuk
Walakpa #1	3,610	32	** 90	-	-	Shublik
Walakpa #2	4,350	41	105	-	-	Argillite

* Circulation time in the hundreds of hours
** Estimated from temperature log

Table 2

TEMPERATURE DATA FROM N.P.R.-4 (NAVY) WELLS

(No circulation times availible)

WELL	DATE SPUD · DATE COMPLETED	DEPTH-FEET	DATE	LOG TYPE	MAXIMUM °F TEMPERATURE
Kaolak #1	7/21/51	1860	8/10/51	"electric" Res.-S.P.	83
	·	2940	8/20/51	"	93
	11/12/51	4150	9/7/51	"	94
		4850	9/22/51	"	96
		6950	11/12/51	"	104
Fish Creek #1	5/18/49	3060	-	"electric" Res.-S.P.	72
	·	4150	6/23/49	"	88
	9/4/49	5075	7/2/49	"	105
		5580	7/9-10/49	"	108
		7010	8/14/49	"	148
		7000	8/16/49 (54 hours since circulation stopped)	Temp.	152
Meade #1	5/2/50	2285	5/28/50	"electric" Res.-S.P.	91
	·	3550	6/15/50	"	89
	7/12/50	4180	6/28/50	"	96
		5200	7/10/50	"	111
		2745	7/24/50	Temp. (behind cemented casing)	160
Oumalik #1	6/11/49	2540	8/7/49	"electric" Res.-S.P.	62
	·	3690	10/9/49	"	74
	4/6/50	5365	10/24/49	"	96
		8025	12/1-2/49	"	130
		8420	12/12/49	"	130
		11475	3/4/50	"	175
		11754	4/6/50	"	175
Simpson #1	6/14/47	6300	2/21/48	Temp.	150
	·	6985	5/15/48	"electric" Res.-S.P.	151
	5/15/48				
North Simpson #1	5/6/50	2430	5/22/50	"electric" Res.-S.P.	67
	·	3780	6/2/50	"	120
	6/2/50				

Table 2 cont.

TEMPERATURE DATA FROM N.P.R.-4 (NAVY) WELLS

(No circulation times availible)

WELL	DATE SPUD · DATE COMPLETED	DEPTH-FEET	DATE	LOG TYPE	MAXIMUM °F TEMPERATURE
Titaluk #1	4/22/51	2090	5/14/51	"electric" Res.-S.P.	64
	·	2980	5/13/51	"	84
	7/6/51	3657	6/22/51	"	86
		4020	7/1/51	"	88
Topogoruk #1	6/15/50	1050	11/3/50	Temp. (behind cemented casing)	49
	· 9/28/51	3055	7/18/50	"electric" Res.-S.P.	84
		5990	11/1/50	Temp. (through cemented casing)	120
		6100	10/28/50	"electric Res.-S.P.	100
		6540	11/15/50	"	110
		7745	3/17/51	"	142
		8210	4/16/51	"	155
		8715	4/18/51	"	169
		9790	7/16/51	"	188
East Topogoruk #1	2/18/51	2250	3/23/51	"electric" Res.-S.P.	91
	· 4/12/51	3400	4/10/51	"	116

Table 3

AVAILABLE
DRILL STEM TEST
FORMATION FLUID
TEMPERATURES

FROM WELLS IN
N.P.R.A. - Alaska

Well	Depth Feet	Temperature °C	Temperature °F	Formation	Remarks
J. W. Dalton #1	7,965	104	219	Sadlerochit	Oil and Gas shows some heavy oil recovered. Plugged and abandoned.
	8,130	77	170 est.	Sadlerochit	
	8,401	100	212	Lisburne Group	
	8,479	104	220	Lisburne Group	
	8,520	104	220 est.	Lisburne Group	
West Dease #1	3,721	39	102	Kingak	Oil and gas shows. Plugged and abandoned.
Drew Point #1	5,922	54	130	Torok	Poor oil and gas shows. Plugged and abandoned.
	7,547	77	170 est.	Shublik	
	7,810	84	184	Sadlerochit	
W. T. Foran #1	7,461	88	190	Pebble Shale "Sand"	Oil and gas shows. Plugged and abandoned.
	8,176	94	201	Kavik	
	8,271	85	185	Lisburne Group	
	8,277	87	188	Lisburne Group	
Ikpikpuk #1	6,847	54	130	Torok	Gas shows. Plugged and abandoned.
	7,406	68	154	Pebble Shale	
North Inigok #1	8,220	90	193.7	Kingak	Gas shows. Plugged and abandoned.
Lisburne #1	7,005	48	118	Shublik	Gas shows. Plugged and abandoned.
	7,600	52	125	Lisburne Group	
	11,608	73	164	Lisburne Group	
Seabee #1	2,670	20	68	Torok	Oil and gas shows. Plugged and abandoned.
	5,384	48	120	Torok	
	5,385	38	100 est.	Torok	
	5,391	36	96	Torok	
East Simpson #2	7,153	88	190 est.	Sadlerochit	Oil and gas shows. Plugged and abadoned.

Table 3 cont.

DRILL STEM TEST
FORMATION FLUID
TEMPERATURES

Well	Depth Feet	Temperature °C	Temperature °F	Formation	Remarks
South Simpson #1	6,485	68	155	Pebble Shale	Dry. Plugged and abandoned.
Tulageak #1	3,815	17	62	Shublik	Poor oil shows. Plugged and abandoned.
Walakpa #1	2,103 2,116	18 20	65 68	Kingak Kingak	Gas shows. Plugged and abandoned.
Walakpa #2	2,575	22	72	Pebble Shale "sand"	Gas well - "Walakpa" sand. Temporarily abandoned.
BARROW AREA WELLS					
South Barrow #7	2,180	23	74	Pebble Shale "sand"	Gas well
South Barrow #9	2,125 2,424	23 23	73 73	Pebble Shale "sand" Kingak "Barrow Sand"	Gas well
South Barrow #10	2,230 2,240	11 11	52 52	Pebble Shale Pebble Shale	Gas well
South Barrow #11	2,171	20	68	Pebble Shale	Gas well
South Barrow #12	2,085 2,246	26 26	78 est. 78 est.	Kingak Sag River	Dry. Suspended
South Barrow #13	1,985 2,084 2,246	26 10 26	78 est. 50 est. 78 est.	Pebble Shale Pebble Shale Kingak	Gas shows. Suspended as marginal gas well.
South Barrow #14	1,906	11	52	Kingak	Gas well
South Barrow #15	2,130 2,145 2,270	13 9 9	55 est. 48 48	Kingak "Barrow Sand" Kingak "Barrow Sand" Kingak "Barrow Sand"	Gas well

Table 3 cont.

DRILL STEM TEST
FORMATION FLUID
TEMPERATURES

Well	Depth Feet	Temperature °C	Temperature °F	Formation	Remarks
South Barrow #17	1,679	25	77	Pebble Shale	Suspended as edge well. Produces water with gas.
	2,135	32	90 est.	Kingak "Barrow Sand"	
	2,302	43	110	Sag River	
	2,323	31	87	Sag River	
South Barrow #18	2,085	8	46	Kingak "Barrow Sand"	Gas well
South Barrow #19	2,217	21	70	Sag River	Gas well
South Barrow #20	2,135	18	65 est.	Kingak "Barrow Sand"	Oil and gas shows. Suspended as marginal oil producer.

Appendix 1

TABLES OF CIRCULATION TIMES, LOG TYPES AND MAXIMUM RECORDED TEMPERATURES

Tables read from left to right. The "Depth" column records the calculated depth (50 feet from bottom of logging tool) at which the maximum temperature was recorded. The "Date/Time Penetration of Depth" records the time the drill bit penetrated the rock at depth. The next column(s) record any successive drilling, coring, reaming, circulation or recirculation from the time of penetration of depth to the beginning of logging operation (some wells require recirculation during logging runs and are so noted). The "Total Hours of Circulation" column sums the individual circulation periods in the previous column(s). The "Date/Time Logging Tool on Bottom" column records the time at which the logging tool reached bottom hole. The "Hours Since Last Circulation Stopped" column records the time difference in hours between the column of last circulation and the column of logging tool on bottom. The "Log Type" column is self explanatory with abbreviations as follows: DIL - Dual Induction Laterlog; BHC - Borehole Compensated Sonic log; FDC - Formation Density Log; HRD (HDT) - High Resolution Dipmeter; CNL - Compensated Neutron Log; MLL - Microlaterlog; LSS - Long - Spaced Sonic; DLL - Dual Laterlog; CBL - Cement Bond Log; Temp #1 - Temperature Log Run #1; Temp 2 - Temperature Log Run #2. The next column "oF Actual Recorded Temperature" is the maximum temperature recorded. The "Remarks" column indicates particular or general problems and/or inconsistencies in the data.

Well: Atigaru Point #1 Date Spud: January 12, 1977 Date Completed: March 18, 1977

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
8100	2/5 2030	2/5 2330	2/6 0030	2/6 0600			8.5	2/6 1200	6	DIL	168	
8100	2/5 2030	2/5 2330	2/6 0030	2/6 0600			8.5	2/6 1400	8	BHC	174	
8100	2/5 2030	2/5 2330	2/6 0030	2/6 0600			8.5	2/6 1700	11	FDC	177	
8100	2/5 2030	2/5 2330	2/6 0030	2/6 0600			8.5	2/6 2300	17	HRD	178	
11,480	3/9 0800	3/10 0300					19	3/10 0800	5	DIL	240	
11,480	3/9 0800	3/10 0300					19	3/10 1300	10	FDC	249	
11,480	3/9 0800	3/10 0300					19	3/10 1530	12.5	BHC	249	
11,480	3/9 0800	3/10 0300					19	3/11 0230	23.5	HRD	256	

Well: Awuna #1 Date Spud: March 1, 1980 Date Completed: April 20, 1981

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
5240	4/29 1400	4/29 2230	4/30 0300	4/30 1530							21 *	4/30 2030	5	DIL	121	*Driller's log indicates 3 hrs less circulatio time.
5240	4/29 1400	4/29 2230	4/30 0300	4/30 1530							21 *	4/30 2300	7.5	FDC	122	
5240	4/29 1400	4/29 2230	4/30 0300	4/30 1530							21 *	5/1 0300	11.5	BHC	122	
8255	1/21 2200	1/22 0430	1/22 1330	1/23 1100	1/23 1400	1/23 1900	1/24 0800	1/24 1500	1/24 1630	1/24 1930	43 **	1/25 0000	4.5	DIL	137	** Loggers did not record
8255	1/21 2200	1/22 0430	1/22 1330	1/23 1100	1/23 1400	1/23 1900	1/24 0800	1/24 1500	1/24 1630	1/24 1930	43	1/25 0400	8.5	BHC	137	additional 3 hrs. of circu-lation.
8255	1/21 2200	1/22 0430	1/22 1330	1/23 1100	1/23 1400	1/23 1900	1/24 0800	1/24 1500	1/24 1630	1/24 1930	43	1/25 1100	15.5	FDC	137	
8255	1/21 2200	1/22 0430	1/22 1330	1/23 1100	1/23 1400	1/23 1900	1/24 0800	1/24 1500	1/24 1630	1/24 1930	43	1/25 1400	18.5	CNL/ FDC	137	
11185	4/15 0930	4/15 2230									13	4/16 0600	7.5	Temp #1	179	
11135	4/13 1400	4/14 1000	4/14 2030	4/15 2230							46	4/16 0900	10.5	DIL	180	
11135	4/13 1400	4/14 1000	4/14 2030	4/15 2230							46	4/16 1230	14	BHC	180	
11140	4/13 1700	4/14 1000	4/14 2030	4/15 2230	4/16 1500	4/17 0100					53	4/17 0700	6	FDC	177	
11140	4/13 1700	4/14 1000	4/14 2030	4/15 2230	4/16 1500	4/17 0100					53	4/17 1130	10.5	HRD	180	
11160	4/14 0800	4/14 1000	4/14 2030	4/15 2230	4/16 1500	4/17 0100					38	4/17 2300	22	Temp #2	198	

Awuna #1 at 8,255 feet at temperature of 137°F was recorded on four consecutive logging runs and the records have not been used.

Well: J. W. Dalton #1 Date Spud: May 7, 1979 Date Completed: August 1, 1979

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
7480	5/27 1800	5/27 2330	5/28 0530	5/28 1000	5/28 1400	5/28 1700	13	5/28 2400	7 *	DIL	134	*Loggers did not provide relevant data on log headings. All times are estimates from driller's log. **Estimated from driller's log.
7480	5/27 1800	5/27 2330	5/28 0530	5/28 1000	5/28 1400	5/28 1700	13	5/29 0500	12	FDC	154	
7480	5/27 1800	5/27 2330	5/28 0530	5/28 1000	5/28 1400	5/28 1700	13	5/29 1300	19	BHC	160	
7480	5/27 1800	5/27 2330	5/28 0530	5/28 1000	5/28 1400	5/28 1700	13	5/29 1600	23 **	HRD	164	
9370	2/28 0200	6/28 0300	6/28 1300	6/28 1800 **			6	6/29 0100	7	Temp #1	201	**Time circulation stopped taken from driller's log.
9310	6/27 1130	6/27 1730	6/27 2330	6/28 0300	6/28 1300	6/28 1800 **	14.5	6/29 0815	14.25	DIL	210	
9310	6/27 1130	6/27 1730	6/27 2330	6/28 0300	6/28 1300	6/28 1800 **	14.5	6/29 2100	27	FDC	212	Loggers did not supply relevant data.
9310	6/27 1130	6/27 1730	6/27 2330	6/28 0300	6/28 1300	6/28 1800 **	14.5	6/30 1600	48	BHC	213	
9310	6/27 1130	6/27 1730	6/27 2330	6/28 0300	6/28 1300	6/28 1800 **	14.5	-	-***	HRD	213	*** Loggers did not supply relevant data.
9360	3/27 2330	6/28 0300	6/28 1300	6/28 1800 **			6	7/1 0100	55	Temp #2	222	

Well: West Dease #1 Date Spud: February 19, 1980 Date Completed: March 26, 1980

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
4165	3/22 0800	3/22 1130	3/22 1930	3/22 2200					5	3/23 0100	3	Temp #1	102	
4115	3/21 1330	3/21 2200	3/22 0430	3/22 1130	3/22 1930	3/22 2200			18	3/23 0430	*6.5	DIL	103	
4115	3/21 1330	3/21 2200	3/22 0430	3/22 1130	3/22 1930	3/22 2200	3/23 0930	3/23 1200	20.5	3/23 1530	3.5	FDC	98	
4115	3/21 1330	3/21 2200	3/22 0430	3/22 1130	3/22 1930	3/22 2200	3/23 0930	3/23 1200	20.5	3/23 1800	6	BHC	100	
4115	3/21 1330	3/21 2200	3/22 0430	3/22 1130	3/22 1930	3/22 2200	3/23 0930	3/23 1200	20.5	3/23 2200	10	MLL	103	
4115	3/21 1330	3/21 2200	3/22 0430	3/22 1130	3/22 1930	3/22 2200	3/23 0930	3/23 1200	20.5	3/23 2400	12	HRD	102	
4165	3/22 0800	3/22 1130	3/22 1930	3/22 2200	3/23 0930	3/23 1200			7.5	3/24 0400	16 *	Temp #2	101	*Discrepancy with drilling log and E-loggers log.

West Dease #1 at 4,165 feet (T.D.) data from the dual temperature logs were not used because recirculation during the logging run changed the total hours of circulation (t_k) for the second temperature log run as well as starting over on time since circulation (Δt).

Well: Drew Point #1 Date Spud: January 13, 1978 Date Completed: March 13, 1978

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
6830	2/5 05:00	2/6 0030					10	2/6 0400	3.5	DIL	122	
6830	"	2/6 0030					"	2/6 0700	6.5	BHC	*134	
6830	"	2/6 0030					"	2/6 1000	9.5	FDC/ CNL	142	
6830	"	2/6 0030					"	2/6 1730	17	HRD	152	* Time questionable
7940	3/8 0130	3/8 07:00					5.5	3/8 1030	3.5? *	Temp #1	174	
7900	3/7 1830	"					12.5	3/8 1600	9	DIL	172	
7900	3/7 1830	"					12.5	3/8 2030	13.5	FDC/ CNL	182	
7900	3/7 1830	"					12.5	3/9 0100	18	BHC	185	
7940	3/8 0130	3/8 0700					5.5	3/9 1830	35.5	Temp #2	202	

Well: Cape Halkett #1 Date Spud: March 24, 1975 Date Completed: June 1, 1975

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
7865	4/30 1500	4/30 1900 *					4	5/1 0100	6	Temp	171	Lost circulation zone 7556'.
7820	4/30 0030	4/30 0130	4/30 0800	4/30 1900 *			12	5/1 0200	7	DIL	-	
7820	4/30 0030	4/30 0130	4/30 0800	4/30 1900 *			12	5/1 0600 **	11	BHC	152	* E-loggers heading date one
7820	4/30 0030	4/30 0130	4/30 0800	4/30 1900 *			12	5/1 0900	14	FDC	157	day off.
7820	4/30 0030	4/30 0130	4/30 0800	4/30 1900 *			12	5/1 1500	20	HRD	161	** Estimated
9850	5/20 0700	5/20 1900					12	5/21 0300	8	DIL	200	
9850	5/20 0700	5/20 1900					12	5/21 0430	9.5	BHC	208	
9850	5/20 0700	5/20 1900					12	5/21 1700	22	HRD	208	

Well: West Fish Creek #1 Date Spud: February 14, 1977 Date Completed: April 27, 1977

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
9020	3/14 0900	3/14 1200	3/14 1300	3/14 1500	3/14 1600	3/14 1900	3/14 2000	3/14 2300	11	3/15 0700	8	DIL	168	
9020	3/14 0900	3/14 1200	3/14 1300	3/14 1500	3/14 1600	3/14 1900	3/14 2000	3/14 2300	11	3/15 0930	10.5	BHC	172	
9020	3/14 0900	3/14 1200	3/14 1300	3/14 1500	3/14 1600	3/14 1900	3/14 2000	3/14 2300	11	3/15 1500	16	FDC/ CNL	186	
9020	3/14 0900	3/14 1200	3/14 1300	3/14 1500	3/14 1600	3/14 1900	3/14 2000	3/14 2300	11	3/15 2100	22	HRD	186	

Well: South Harrison Bay #1 Date Spud: November 21, 1976 Date Completed: February 8, 1977

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
8330	12/23 0300	12/23 1630					13.5	12/23 2130	5	DIL	156	
8330	12/23 0300	12/23 1630					13.5	12/24 0200	9.5	BHC	161	
8330	12/23 0300	12/23 1630					13.5	12/24 0630	14	CNL/ FDC	174	
11220	1/27/77 0300	1/27 2030	1/27 2200	1/28 0100			20.5	1/28 0900	8	DIL	242	
11220	1/27/77 0300	1/27 2030	1/27 2200	1/28 0100			20.5	1/28 1430	13.5	BHC	244	
11220	1/27/77 0300	1/27 2030	1/27 2200	1/28 0100			20.5	1730	16.5	CNL/ FDC	248	
11220	1/27/77 0300	1/27 2030	1/27 22000	1/28 0100			20.5	2130	20.5	HRD	248	

Well: W. T. Foran Date Spud: March 7, 1977 Date Completed: April 24, 1977

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
7540	3/29 0400	3/29 1030	3/29 2130	3/30 0400			13	3/30 1000	6	DIL	140	
7540	3/29 0400	3/29 1030	3/29 2130	3/30 0400			13	3/30 1300	9	BHC	152	
7540	3/29 0400	3/29 1030	3/29 2130	3/30 0400			13	3/30 1800	14	FDC	-	
7540	3/29 0400	3/29 1030	3/29 2130	3/30 0400			13	3/31 2400	20	HRD	162	
8820	4/15 0800	4/15 1600					8	4/15 2200	6	DIL	-	
8820	4/15 0800	4/15 1600					8	4/16 0200	10	CNL/ FDC	190	
8820	4/15 0800	4/15 1600					8	4/16 1000	18	BHC	195	
8820	4/15 0800	4/15 1600	4/16 1830	4/16 2200			11.5	4/17 0400	6	HRD	185	

Well: Ikpikpuk #1 Date Spud: November 28, 1978 Re Entered: January 7, 1980 Date Completed: February 28, 1980

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
9860	1/26 1900	1/27 0300					8	1/27 2000	17	DIL	182	
9860	1/26 1900	1/27 0300					8	1/28 0730	28.5	BHC	182	
9860	1/26 1900	1/27 0300					8	1/28 1100	32	HDT	187	
9860	1/26 1900	1/27 0300	1/28 2000	1/29 0500			17	1/29 1130	6.5	CNL	158	Recirculate 9 hours.
14160	4/7 0200	4/7 1600					14	4/8 0500	13	DIL	252	
14160	4/7 0200	4/7 1600					14	4/8 1000	18	CNL	262	
14160	4/7 0200	4/7 1600					14	4/8 1600	24	BHC	268	
14160	4/7 0200	4/7 1600					14	4/8 2300	31	HDT	272	Well suspended until re-circulation 12/30/79.
15435	2/8 1400		78 hours of circulation 84 hours of non-circulation			2/13 0800	78	2/14 0200	18	Temp #1	288	
15340	2/1 1930					2/13 0800	135	2/14 0700	23	DIL	294	
15340	2/1 1930		135 hours of circulation 141 hours of non-circulation			2/13 0800	135	2/14 0930	25.5	BHC	294	
15340	2/1 1930					2/13 0800	135	2/14 1230	28.5	FDC	294	
15404	2/3 2000		95 hours of circulation 129 hours of non-circulation			2/13 0800	95	2/15 0400	44	Temp #2	294	

Ikpikpuk #1 at 15,340 feet the maximum temperatures are equal indicating either thermometer failure or replicate recording. Bottom hole temperatures from the temperature logs were measured at different depths therefore not used in extrapolation.

Well: Inigok #1 Date Spud: June 7, 1978 Date Completed: May 22, 1979

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
8260	8/2 0200	8/2 0500	8/3 0300	8/3 1000	8/3 1700	8/3 2300			16	8/4 1000	11	DIL	139	
8260	8/2 0200	8/2 0500	8/3 0300	8/3 1000	8/3 1700	8/3 2300			16	8/4 1730	18.5	CNL	144	
8260	8/2 0200	8/2 0500	8/3 0300	8/3 1000	8/3 1700	8/3 2300			16	8/5 0030	25.5	BHC	149	
12200	9/10 0600	9/11 1700	9/12 0600	9/12 1000	9/13 0400	9/13 1900			30	9/14 0330	8.5	DIL	220	
12200	9/10 0600	9/11 1700	9/12 0600	9/12 1000	9/13 0400	9/13 1900			30	9/14 1400	19	CNL	210	
12240	9/10 1030	9/11 1700	9/12 0600	9/12 1000	9/13 0400	9/13 1900	9/15 0700	9/15 1500	38	9/15 2115	6.25	BHC	-	Thermometer broken
12240	9/10 1030	9/11 1700	9/12 0600	9/12 1000	9/13 0400	9/13 1900	9/15 0700	9/15 1500	38	9/16 0200	11	HDT	201	
15900	12/4/78 0600					2/13/79 1745			788.75	2/14 2300	29	DLL	296	These 3 different hours of circula-
15900	12/4/78 0600		788.75	hours of circulation		2/13/79 1745			788.75	2/15 0600	36	FDC	302	tion reflect the differ- ing depths
15900	12/4/78 0600		915.75	hours of non-circulation *		2/13/79 1745			788.75	2/17 0400	82	HDT	305	to which the logging tool reached
														during the RUN
16890	12/17 2200		563.75 hours of circulation 828.25 hours of non-circulation *			2/13 1745			563.75	2/14 1030	16.75	BHC #2	342	

Inigok #1 at 12,200 feet the thermometer is recorded as broken and therefore the temperatures were not extrapolated. At both 15,900 and 17,300 feet circulation time is in the hundreds of hours and extrapolation is tentative.

Well: Inigok #1 Date Spud: June 7, 1978 Date Completed: May 22, 1979

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
17300	12/23 0800		469 hours of circulation 779 hours of non-circulation			2/13 1745	469	2/14 0300	9.25	DIL	341	
17300	12/23 0800					2/13 1745	469	2/14 0630*	12.75	BHC #1	342	*Estimated
19200	4/24/79 0600	4/24 0630	4/24 1500	4/25 2000			29.5	4/26 0430	8.5	DIL	348	
19200	4/24/79 0600	4/24 0630	4/24 1500	4/25 2000			29.5	4/26 0800	12	FDC	348	
19200	4/24/79 0600	4/24 0630	4/24 1500	4/25 2000	4/26 1800	4/27 0000	35.5	4/27 1300	13	BHC	350	
19200	4/24/79 0600	4/24 0630	4/24 1500	4/25 2000	4/26 1800	4/27 0000	35.5	4/27 1600	16	HDT	352	
20040	5/11/79 1900	5/12 1030					15.5	5/12 1930	9	DIL	362	
20040	5/11/79 1900	5/12 1030					15.5	5/12 2200	11.5	CNL	365	

Well: North Inigok Date Spud: February 13, 1981 Date Completed: April 4, 1981

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
8430	3/9 1930	3/10 0200	3/10 0400	3/10 0800					10.5	3/10 1830	10.5	DIL	168	
8430	3/9 1930	3/10 0200	3/10 0400	3/10 0800					10.5	3/10 2200	14	FDC/ CNL	179	
8430	3/9 1930	3/10 0200	3/10 0400	3/10 0800					10.5	3/11 0245	18.75	BHC	183	
8430	3/9 1930	3/10 0200	3/10 0400	3/10 0800					10.5	3/11 0900	25	LSS	193	
8430	3/9 1930	3/10 0200	3/10 0400	3/10 0800					10.5	3/11 1530	31.5	HRD	198	
10170	3/28 0830	3/28 1000							1.5	3/28 1600	6	Temp #1	218	
10120	3/27 0500	3/27 0730	3/27 1230	3/27 1900	3/28 0400	3/28 1000			15	3/28 2300	13	CNL/ FDC	228	
10120	3/27 0500	3/27 0730	3/27 1230	3/27 1900	3/28 0400	3/28 1000			15	3/29 0630	20.5	DLL	230	
10120	3/27 0500	3/27 0730	3/27 1230	3/27 1900	3/28 0400	3/28 1000			15	3/29 1000	24	BHC	236	
10110	3/27 0400	3/27 0730	3/27 1230	3/27 1900	3/28 0400	3/28 1000	3/29 1830	3/29 2000 *	16.5	3/20 0300	7	HRD	224	*Discrepancy drilling log
10160	3/28 0600	3/28 1000	3/29 1830	3/29 2000 *					5.5	3/30 2200	26	Temp #2	249	with E-loggers

Well: North Kalikpik #1 Date Spud: February 27, 1978 Date Completed: April 14, 1978

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
7350	4/7 2000	4/8 0130	4/8 0630	4/8 0800	4/8 1230	4/8 1630	4/8 1730	4/8 1930	13	4/9 0200	6.5	DIL	148	
7350	4/7 2000	4/8 0130	4/8 0630	4/8 0800	4/8 1230	4/8 1630	4/8 1730	4/8 1930	13	4/9 0615	10.5	CNL	165	
7350	4/7 2000	4/8 0130	4/8 0630	4/8 0800	4/8 1230	4/8 1630	4/8 1730	4/8 1930	13	4/9 1200	16.5	BHC	176	
7350	4/7 2000	4/8 0130	4/8 0630	4/8 0800	4/8 1230	4/8 1630	4/8 1730	4/8 1930	13	4/10 0030	22.5	HDT	184	

Well: Koluktak #1 Date Spud: March 24, 1981 Date Completed: April 19, 1981

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
5872	4/15 1300	4/15 1500	4/15 1700	4/15 1800					3	4/15 2300	5	Temp #1	135	
5825	4/15 0900	4/15 1500	4/15 1700	4/15 1800					7	4/16 0430	10.5	DIL	137	
5825	4/15 0900	4/15 1500	4/15 1700	4/15 1800					7	4/16 0900	15	FDC	139	
5825	4/15 0900	4/15 1500	4/15 1700	4/15 1800					7	4/16 1500	21	BHC	140	
5400 *	4/13 0100	4/13 1100	4/13 1430	4/14 1500	4/14 2330	4/15 1500	4/15 1700	4/15 1800	51	4/17 1300	43	Temp #2	139 **	*Tool could not reach bottom hole. **Temperature 425 feet uphole

Well: Kugrua #1 Date Spud: February 12, 1978 Date Completed: May 29, 1978

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
8650	4/1 0400	4/4 1500	4/5 1500	4/5 1900			87	4/6 0245	7.75	DIL	129	Lost circulation zone at 8700'
8650	4/1 0400	4/4 1500	4/5 1500	4/5 1900			87	4/6 0600	11	CNL	149	
8650	4/1 0400	4/4 1500	4/5 1500	4/5 1900			87	4/6 1330	18.5	BHC	156	
8650	4/1 0400	4/4 1500	4/5 1500	4/5 1900	4/6 2330	4/7 0230	90	4/7 1100	8.5	HRD	147	
12540	5/20 0200	5/20 1400	5/21 1430	5/21 1700			14.5	5/21 2230	5.5	DIL	226	
12540	5/20 0200	5/20 1400	5/21 1430	5/21 1700			14.5	5/22 0500	12	CNL	250	
12540	5/20 0200	5/20 1400	5/21 1430	5/21 1700			14.5	5/22 1000	17	BHC	252	
12540	5/20 0200	5/20 1400	5/21 1430	5/21 1700			14.5	5/22 1200	19	HRD	-	

Well: Kuyanak #1 Date Spud: February 13, 1981 Date Completed: March 31, 1981

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
4660	2/26 1030	2/26 1500	2/26 1800	2/26 2030			7	2/27 0230	6	FDC	120	
4700	2/26 1230	2/26 1500	2/26 1800	2/26 2030	2/27 1200	2/28 0200	19	2/28 0800	6	DIL	117	
4700	2/26 1230	2/26 1500	2/26 1800	2/26 2030	2/27 1200	2/28 0200	19	2/28 1130	9.5	BHC	118	
4700	2/26 1230	2/26 1500	2/26 1800	2/26 2030	2/27 1200	2/28 0200	19	2/28 1600	14	LSS	118	
6690	3/26 1700	3/26 2100	2/27 1630 *	2/28 0000			11.5	0400	4	Temp #1	142	*Two short wiper trips made during
6630	3/25 2130	3/26 0930	3/26 1500	3/26 2100	2/27 1630 *	2/28 0000	25.5	0800	8	DLL	142	this following circulation interval.
6630	3/25 2130	3/26 0930	3/26 1500	3/26 2100	2/27 1630 *	2/28 0000	25.5	1400	14	CNL/ FDC	144	
6630	3/25 2130	3/26 0930	3/26 1500	3/26 2100	2/27 1630 *	2/28 0000	25.5	3/ 1700	17	BHC	144	
6682	3/26 1600	3/26 2100	2/27 1630 *	2/28 0000			12.5	3/29 1000	34	Temp #2	156	

Kuyanak #1 at 4,660 feet only one maximum temperature was recorded. At 6,690 feet temperatures from the dual-temperature logs were extrapolated despite the slight depth difference and one hour th difference.

Well: Lisburne #1 Date Spud: June 11, 1979 Date Completed: June 2, 1980

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
1460	6/26 2000	6/27 0800	6/27 1200	6/27 1930			17.5	6/27 2200	2.5	DIL	102	
1460	6/26 2000	6/27 0800	6/27 1200	6/27 1930			17.5	6/28 0030	5	BHC	103	
4470	7/23 0800	7/23 1600	7/23 1700	7/23 2130	7/23 2400	7/24 1200	24.5	7/24 1630	4.5	DIL	112	
4470	7/23 0800	7/23 1600	7/23 1700	7/23 2130	7/23 2400	7/24 1200	24.5	7/25 0330	15.5	BHC	117	
6690	8/15 0200	8/15 1400 *	8/21 1930	8/22 0100	8/22 0330	8/22 0600	20	8/22 1200	6	DIL	117	*Circulate at casing shoe 4378'
6690	8/15 0200	8/15 1400 *	8/21 1930	8/22 0100	8/22 0330	8/22 0600	20	8/22 1400	8	BHC	117	8/15 1400 to 8/22 1930
7975	11/22 1800	11/23 0100	11/23 0400	11/23 0700 **			10	11/23 1330	6.5	DIL	124	**Descrepancy between drilling
7975	11/22 1800	11/23 0100	11/23 0400	0700			10	11/23 1730	10.5	FDC	126	time log and E-loggers.
7975	11/22 1800	11/23 0100	11/23 0400	0700			10	11/23 2200	15	BHC	128	
7975	11/22 1800	11/23 0100	0400	0700			10	11/24 0230	19.5	HRD	129	

Lisburne #1 at 6,690 feet the two temperatures were recorded equal and not considered reliable, therefore not extrapolated.

Well: Lisburne #1 Date Spud: June 11, 1979 Date Completed: June 2, 1980

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (3)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
13600	2/26/80 1600	2/27 0030	2/27 0600	2/28 0000					26.5	2/28 0800	8	DIL	160	
13600	2/26/80 1600	2/27 0030	2/27 0600	2/28 0000					26.5	2/28 1230	12.5	BHC	185	
13600	2/26/80 1600	2/27 0030	2/27 0600	2/28 0000					26.5	2/28 1730	17.5	FDC	188	
13600	2/26/80 1600	2/27 0030	2/27 0600	2/28 0000					26.5	2/29 0530	29.5	HRD	190	
16955	5/17 1830	5/17 2330	-	-	5/18 2200	5/19 0930	5/20 1100	5/20 1330 *	19	5/20 2230	9	Temp #1	228	*Discrepancy with drilling log and E-loggers
16925	5/16 1900	5/16 2400	5/17 0630	5/17 2330	5/18 2200	5/19 0930	5/20 1100	5/20 1330	36	5/21 0230	11	DIL	228	
16925	5/16 1900	5/16 2400	5/17 0630	5/17 2330	5/18 2200	5/19 0930	5/20 1100	5/20 1330	36	5/21 1315	23.75	BHC	228	
16925	5/16 1900	5/16 2400	5/17 0630	5/17 2330	5/18 2200	5/19 0930	5/20 1100	5/20 1330	36	5/22 0300	37.5	FDC	-	
16925	5/16 1900	5/16 2400	5/17 0630	5/17 2330	5/18 2200	5/19 0930	5/20 1100	5/20 1330	36	5/22 1000	44.5	HRD	-	
16955	5/17 1830	5/17 2330	-	-	5/18 2200	0930	5/20 1100	5/20 1330	19	5/24 0700 *	66.5	Temp #2	246	-

Well: South Meade #1 Date Spud: February 7, 1978 Date Completed: January 22, 1979
Re-entered: December 4, 1978

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
8000	4/27 0600	4/27 1730	4/28 0730	4/28 2400	4/29 0500	4/29 2315	51.75	4/30 0800	7.5	DIL	140	
8000	4/27 0600	4/27 1730	4/28 0730	4/28 2400	4/29 0500	4/29 2315	51.75	5/1 0700	28.5	BHC	214	
8000	4/27 0600	4/27 1730	4/28 0730	4/28 2400	4/29 0500	4/29 2315	51.75	5/1 1300	34.5	CNL	218	
8470	5/10 1000	5/10 2000	5/11 0500	5/11 2200			27	4/12 0430	6.5	DIL	194	
8470	5/10 1000	5/10 2000	5/11 0500	5/11 2200			27	4/12 0700	9	BHC	215	Well Suspended Circulation
												Stopped 5/15/78 Re-Circulation Began 12/1/78
9945	1/13 1830	1/13 1900	1/13 2000	1/13 2200			2.5	1/14 0600	8	Temp #1	280 *	*Reading taken 1 minute after tool reached bottom
9900	1/12 2100	1/13 0100	1/13 0630	1/13 1900	1/13 2000	1/13 2200	18.5	1/14 1030	12.5	DIL	236	
9900	1/12 2100	1/13 0100	1/13 0630	1/13 1900	1/13 2000	1/13 2200	18.5	1/14 1400	16	BHC	246	
9900	1/12 2100	1/13 0100	1/13 0630	1/13 1900	1/13 2000	1/13 2200	18.5	1/14 1700	19	CNL/ FDC	254	
9945	1/13 1830	1/13 1900	1/13 2000	1/13 2200			2.5	1/15 0700	33	Temp #2	291 *	*Reading taken 5 minutes after tool
												reached bottom

South Meade #1 at 8,470 feet the extrapolated temperature plots at 330oF from two points but is not considered reliable in view of deeper measurements.

Well: Beard Bay Date Spud: January 26, 1979 Date Completed: April 13, 1979

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
8550	3/11 2100	3/12 1500							18	3/12 2130	6.5	DIL	145	
8550	3/11 2100	3/12 1500							18	3/13 0300	12	FDC/ CNL	162	
8550	3/11 2100	3/12 1500							18	3/13 1000	19	BHC	165	
8550	3/11 2100	3/12 1500							18	3/13 1700	26	HRD	167	
10220	4/6 2000	4/6 2330	4/7 0130	4/7 0500					7	4/7 1800	13	Temp #1	212	
10180	4/5 2000	4/5 2330	4/6 0530	4/6 1030	4/6 2000	4/6 2330	4/7 0130	4/7 0500	15.5	4/7 2200	17	DIL	208	
10180	4/5 2000	4/5 2330	4/6 0530	4/6 1030	4/6 2000	4/6 2330	4/7 0130	4/7 0500	15.5	4/8 0330	22.5	FDC/ CNL	210	
10180	4/5 2000	4/5 2330	4/6 0530	4/6 1030	4/6 2000	4/6 2330	4/7 0130	4/7 0500	15.5	4/8 0600	25	BHC	212	
10180	4/5 2000	4/5 2330	4/6 0530	4/6 1030	4/6 2000	4/6 2330	4/7 0130	4/7 0500	15.5	4/8 1330	32.5	HRD	# –	*Temperature not recorded
10220	4/6 2000	4/6 2330	4/7 0130	4/7 0500					7	4/8 2200	41	Temp #2	224	

Well: Seabee #1 Date Spud: July 1, 1979 Date Completed: April 15, 1980

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (3)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (4)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (5)	Date/Time Re-circulation stopped
3950	7/25 0330	7/25 1030	7/25 1300	7/25 1600								
3950	7/25 0330	7/25 1030	7/25 1300	7/25 1600								
3950	7/25 0330	7/25 1030	7/25 1300	7/25 1600								
3950	7/25 0330	7/25 1030	7/25 1300	7/25 1600								
6470	8/14 1600	8/15 0100	8/15 0930	8/15 1400	8/18 1200	8/18 2145						
6470	8/14 1600	8/15 0100	0930	1400 *	1200	2145						
9930	11/9 1800	11/20 1700	11/20 1800	11/20 2000								
9930	11/19 1800	11/20 1700	11/20 1800	11/20 2000								
9930	11/19 1800	11/20 1700	11/20 1800	11/20 2000								
9930	11/19 1800	11/20 1700	11/20 1800	11/20 2000								
12740	1/14/80 1630	1/15 0100	1/15 1800	1/16 1200	1/16 1800	1/17 0300	1/17 0700	1/17 1000	1/17 1500	1/17 1900	1/18 1400	1/18 1800
12730	1/14/80 1330	1/15 0100	1/15 1800	1/16 1200	1/16 1800	1/17 0300	1/17 0700	1/17 1000	1/17 1500	1/17 1900	1/18 1400	1/18 1800
12785*	1/15/80 2200	*Logging tool could not reach bottom T.D. of 15,611'.					Tool stopped at 12,785'.					4/2 0400

Seabee #1 at 3,950 feet the temperatures recorded are equal (96°F) and are not plotted.

continued on next page

Seabee: continued

Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
10	2/25 2100	5	DIL	96	
10	2/26 0030 *	8.5	FDC	96	*Recorded by E-loggers as 2/25, 2430.
10	2/26 0330	11.5	BHC	96	
10	2/26 0730	15.5	HRD	96	
23	8/19 0330	5.75	DIL	110	*Circulate at casing shoe 3921
23	8/19 0600	8.25	FDC	112	for 49.5 hours. see text
25	11/21 0400 *	8 *	DIL	155	*These figures are best estimates
25	11/21 0900 *	13 *	CNL/ FDC	158	based on driller's log.
25	11/21 1330	17.5	BHC	160	
25	11/21 2200	26	HRD	165	
46	1/19 0200	8	DIL	192	
46	1/19 0600	12	BHC	198	
-	4/2 1700	13	FDC	230	

Well: East Simpson #1 **Date Spud:** February 19, 1979 **Date Completed:** April 10, 1979

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
7130	3/19 0600	3/19 2100	3/19 2300	3/20 0200			18	3/20 1030	8.5	DIL	138	
7130	3/19 0600	3/19 2100	3/19 2300	3/20 0200			18	3/20 1500	13	CNL	153	
7130	3/19 0600	3/19 2100	3/19 2300	3/20 0200			18	3/20 2200	20	BHC	158	
7130	3/19 0600	3/19 2100	3/19 2300	3/20 0200			18	3/21 0100	24	HDT		
7740	4/3 1030	4/3 1630	4/3 2330	4/4 0200	4/3 2330	4/4 0200	8.5	4/4 0900	7	Temp #1	163	
7700	4/2 1800	4/3 0400	4/3 1030	4/3 1630	4/3 2330	4/4 0200	18.5	4/4 1100	9	DIL	165	
7700	4/2 1800	4/3 0400	4/3 1030	4/3 1630	4/3 2330	4/4 0200	18.5	4/4 1400	12	BHC	169	
7700	4/2 1800	4/3 0400	4/3 1030	4/3 1630	4/3 2330	4/4 0200	18.5	4/4 1800	16	CNL	172	
7700	4/2 2200	4/3 0400	4/3 1030	4/3 1630	4/3 2330	4/4 0200	18.5	4/4 2300	21	HDT	172(?)	
7740	4/3 1030	4/3 1630	4/3 2330	4/4 0200	4/3 2330	4/4 0200	8.5	4/5 0500	27	Temp #2	182	

Well: East Simpson #2 Date Spud: January 29, 1980 Date Completed: March 15, 1980

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
6380	2/17 0600	2/17 1030	2/17 1200	2/17 1430							7	2/17 1930	5	DIL	135	
6380	2/17 0600	2/17 1030	2/17 1200	2/17 1430							7	2/18 0300	12.5	BHC	145	
7125	DST														190 est.	
7140	2/27 1500	2/27 1830	2/28 0230	2/28 0930	2/28 1430	2/28 1830	2/29 1230	2/29 1745	3/2 1330 *	3/2 1800	24.25	3/2 2230	4.5	DIL	148	*Discrepancy between drilling log and E-Logs
7140	2/27 1500	2/27 1830	2/28 0230	2/28 0930	2/28 1430	2/28 1830	2/29 1230	2/29 1745	3/2 1330	3/2 1800	24.25	3/3 0100	7	BHC	158	
7140	2/27 1500	2/27 1830	2/28 0230	2/28 0930	2/28 1430	2/28 1830	2/29 1230	2/29 1745	3/2 1330	3/2 1800	24.25	3/3 0330	9.5	FDC	160	
7400	3/7 0600	3/7 1800	3/8 0230	3/8 1500	3/9 0230	3/9 1100					33	3/9 2000	9	Temp #1	180	
7460	3/9 0230	3/9 1100									8.5	3/9 2300	12	DIL	180	
7460	3/9 0230	3/9 1100									8.5	3/10 0200	15	FDC	179	
7460	3/9 0230	3/9 1100									8.5	3/10 0600	19	BHC	180	
7505	3/9 0900	3/9 1100	3/10 0800	3/10 1030							4.5	3/10 1900	8.5	Temp #2	194	

East Simpson #2 maximum temperatures from the dual temperature logs were recorded 100 feet apart.

Well: South Simpson #1 Date Spud: March 9, 1977 Date Completed: April 30, 1977

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
7150	4/4 2000	4/5 0300	4/5 0515	4/5 0715			9	4/5 1145	4.5	DIL	145	
7150	4/4 2000	4/5 0300	4/5 0515	4/5 0715			9	4/5 1330	6.75	FDC	145	
7150	4/4 2000	4/5 0300	4/5 0515	4/5 0715			9	4/5 1915	12	BHC	154	
7150	4/4 2000	4/5 0300	4/5 0515	4/5 0715			9	4/6 0300	22.75	HDT	-	
7200	4/5 0300							4/20 0630	26.5	CBL	203*	*Temperature probably
8750	4/18 1445	4/19 0000					9.25	4/19 0600	6	DIL	187	reflects warmer fluid
8750	4/18 1445	4/19 0000					9.25	4/19 1000	10	FDC	196	from 8750' tool stuck
8750	4/18 1445	4/19 0000					9.25	4/19 1300	13	BHC	200	
8750	4/18 1445	4/19 0000					9.25	4/19 1800	18	HDT	-	

Well: East Teshekpuk #1 Date Spud: March 12, 1976 Date Completed: May 11, 1976

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
8280	4/10 0200	4/10 1500	4/10 1700	4/10 1900			15	4/11 0100	6	DIL	172	
8280	4/10 0200	4/10 1500	4/10 1700	4/10 1900			15	4/11 0230	7.5	BHC	180	
8280	4/10 0200	4/10 1500	4/10 1700	4/10 1900			15	4/11 0730	12.5	CNL/ FDC	194	
8280	4/10 0200	4/10 1500	4/10 1700	4/10 1900			15	4/11 1200	17	HRD	198	
10610	5/6 0600	5/6 1300					7	5/6 2000	7	DIL	238	
10610	5/6 0600	5/6 1300					7	5/7 0030	11.5	CNL/ FDC	254	
10610	5/6 0600	5/6 1300					7	5/7 0400	15	BHC	254	
10610	5/6 0600	5/6 1300					7	5/7 0800	19	HRD	262	

Well: Tulageak #1 Date Spud: February 26, 1981 Date Completed: March 23, 1981

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
4000	3/18 1300	3/18 1900	3/19 0100	3/19 0930	3/19 1430	3/19 1830 *	18.5	3/19 2215	3.75	Temp #1	90	*Discrepancy with drilling log and E-loggers
3950	3/18 0130	3/18 1900	3/19 0100	3/19 0930	3/19 1430	3/19 1830 *	29	3/20 0700	12.5	DIL	90	
3950	3/18 0130	3/18 1900	3/19 0100	3/19 0930	3/19 1430	3/19 1830 *	29	3/20 1100	16.5	CNL/ FDC	91	
3950	3/18 0130	3/18 1900	3/19 0100	3/19 0930	3/19 1430	3/19 1830 *	29	3/20 1330	19	BHC	91	
3950	3/18 0130	3/18 1900	3/19 0100	3/19 0930	3/19 1430	3/19 1830 *	29	3/20 1630	22	HRD	-	
4000	3/18 1300	3/18 1900	3/19 0100	3/19 0930	3/19 1430	3/19 1830 *	18.5	3/20 2030	26	Temp #2	96	

Well: Tunalik #1 **Date Spud:** November 10, 1978 **Date Completed:** January 7, 1980

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (5)	Date/Time Re-circulation stopped
8250	1/23/79 08:00	1/24 05:00	1/24 09:00	1/24 13:00								
8250	1/23/79 08:00	1/24 05:00	1/24 09:00	1/24 13:00								
8250	1/23/79 08:00	1/24 05:00	1/24 09:00	1/24 13:00	1/25 20:00	1/26 12:00						
8250	1/23/79 08:00	1/24 05:00	1/24 09:00	1/24 13:00	1/25 20:00	1/26 12:00						
12340	4/6 12:00	4/8 08:00	4/8 16:00	4/30 13:00	5/1 00:30	5/15 02:00	5/15 16:00	5/27 11:00	5/27 24:00	5/29 01:00	5/29 16:00	5/30 21:00
12340	4/6 12:00	4/8 08:00	4/8 16:00	4/30 13:00	5/1 00:30	5/15 02:00	5/15 16:00	5/27 11:00	5/27 24:00	5/29 01:00	5/29 16:00	5/30 21:00
12340	4/6 12:00	4/8 08:00	4/8 16:00	4/30 13:00	5/1 00:30	5/15 02:00	5/15 16:00	5/27 11:00	5/27 24:00	5/29 01:00	5/29 16:00	5/30 21:00
14670	7/14 14:00	1/16 19:00	1/16 23:00	1/17 18:00	1/17 24:00	1/18 14:00	1/18 24:00	1/19 18:00	1/20 01:00	7/23 18:00	7/24 10:00	7/25 01:30
14670	7/14 14:00	1/16 19:00	1/16 23:00	1/17 18:00	1/17 24:00	1/18 14:00	1/18 24:00	1/19 18:00	1/20 01:00	7/23 18:00	7/24 10:00	7/25 01:30
14670	7/14 14:00	1/16 19:00	1/16 23:00	1/17 18:00	1/17 24:00	1/18 14:00	1/18 24:00	1/19 18:00	1/20 01:00	7/23 18:00	7/24 10:00	7/25 01:30
14670	7/14 14:00	1/16 19:00	1/16 23:00	1/17 18:00	1/17 24:00	1/18 14:00	1/18 24:00	1/19 18:00	1/20 01:00	7/23 18:00	7/24 10:00	7/25 01:30
18230	10/25 12:00	10/25 19:30	10/26 04:00	10/27 12:00	10/31 09:00	10/31 12:30	11/1 04:00	11/1 10:30	11/2 03:00	11/2 9:30	11/2 22:00	11/3 09:00
18230	10/25 12:00	10/25 19:30	10/26 04:00	10/27 12:00	10/31 09:00	10/31 12:30	11/1 04:00	11/1 10:30	11/2 03:00	11/2 9:30	11/2 22:00	11/3 09:00
18230	10/25 12:00	10/25 19:30	10/26 04:00	10/27 12:00	10/31 09:00	10/31 12:30	11/1 04:00	11/1 10:30	11/2 03:00	11/2 9:30	11/2 22:00	11/3 03:30
20260	12/20 1900	12/21 1930	12/25 2100	12/26 0700								
20260	12/20 1900	12/21 1930	12/25 2100	12/26 0700								
20260	12/20 1900	12/21 1930	12/25 2100	12/26 0700								

continued on next page

Tunalik #1 at 8,250 feet two sets of data are available because of recirculation and an average temperature is derived. At 12,340 feet, circulation time exceeds 1,000 hours. At 14,670 feet circulation time is in the hundreds of hours. At 20,260 feet, temperatures exceed 400oF and extrapolation is not reasonable.

Tunalik: continued

Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or core or ream) (2)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (1)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
						21	1/24 2130	8.5	DIL	156	
						21	1/25 0930	21.5	BHC	158	
						37	1/26 2000	8	CNL	144	
						37	1/27 0800	20	HDT	148	
						1284*	5/31 0430	7.5	DIL	194	*This number is minus times of non-circulation not recorded in previous columns (approx. 50 hours)
						1284*	5/31 0930	12.5	BHC	196	
						1284*	5/31 1900	22	CNL	203	
						208.5	7/25 2300	20.5	DIL	276	
7/26 14:30	7/27 17:00	7/28 19:00	7/29 21:00	7/29 24:00	7/30 05:00	266	7/30 1500	10	BHC	272	
7/26 14:30	7/27 17:00	7/28 19:00	7/29 21:00	7/29 24:00	7/30 05:00	266	7/13 1900	14	CNL	276	
7/26 14:30	7/27 17:00	7/28 19:00	7/29 21:00	7/29 24:00	7/30 05:00	266	7/30 2300	18	HRD	282	
						66	11/3 1800	9	DIL	333	
						66	11/3 2100	12	FDC	338	
11/4 05:00	11/4 ** 11:00					75	11/5 0330	18.5	BHC	336	
						34.5	12/26 2300	16	DIL	371	**Time circulation stopped is not in agreement with E-loggers
						34.5	12/27 0200	19	BHC	405	
						34.5	12/27 1300	28	velocity	405	

Well: Walakpa #1 Date Spud: December 25, 1979 Date Completed: February 7, 1980

Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
3610	1/22 0600	1/22 1700	1/23 0100	1/23 0345	1/23 0830	1/23 1100	15.25	1/23 1730	6.5	DIL/ BHC	85	
3610	1/22 0600	1/22 1700	1/23 0100	1/23 0345	1/23 0830	1/23 1100	15.25	1/24 0030	13.5	FDC	85	
3610	1/22 0600	1/22 1700	1/23 0100	1/23 0345	1/23 0830	1/23 1100	15.25	1/24 0400	17	HRD	85	

Walakpa #1 at 3,610 feet the temperatures recorded during the three logging runs is constant at 85oF and not plotted. An estimation of 90oF is made for this depth.

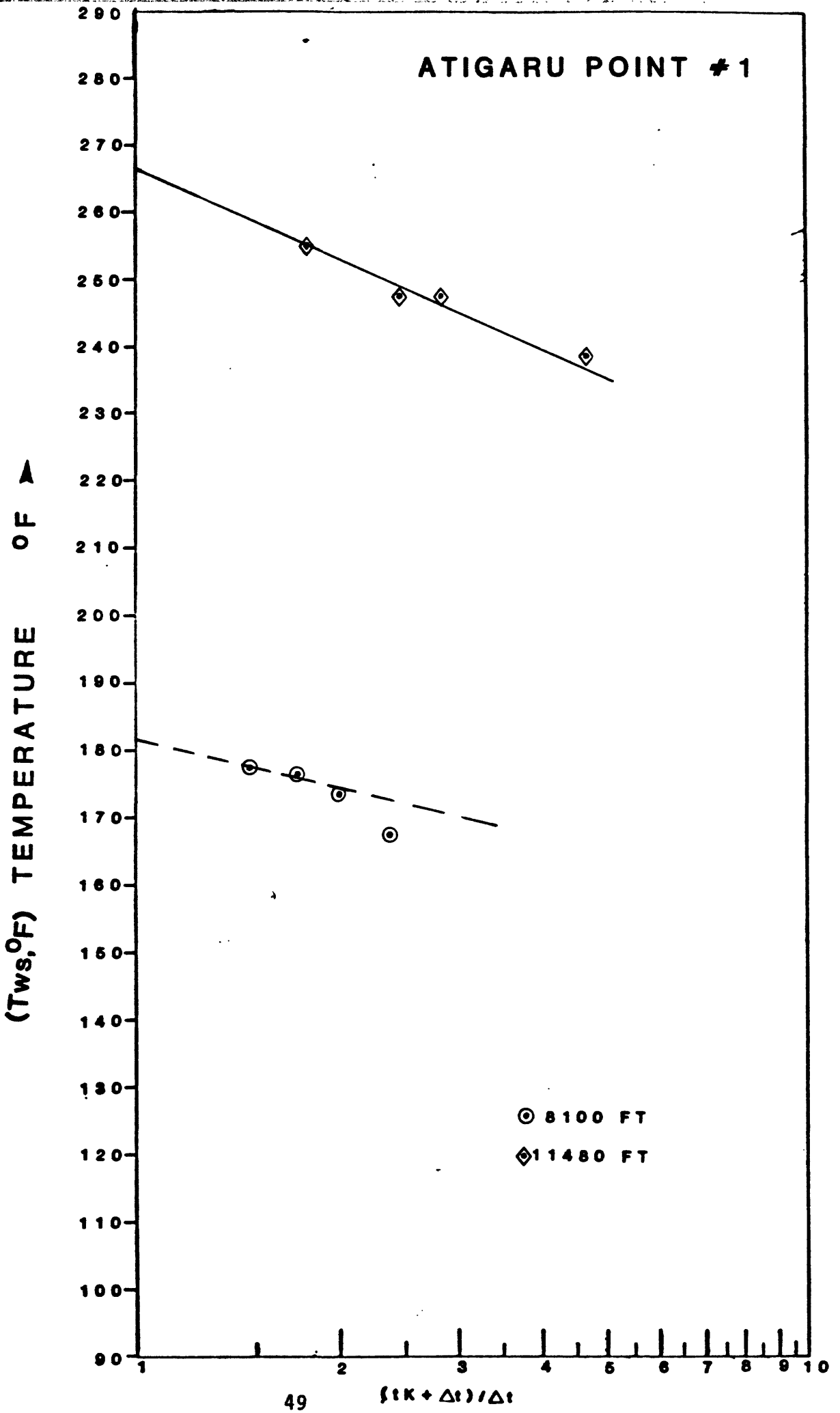
Well: Walakpa #2 Date Spud: January 3, 1981 Date Completed: February 15, 1981

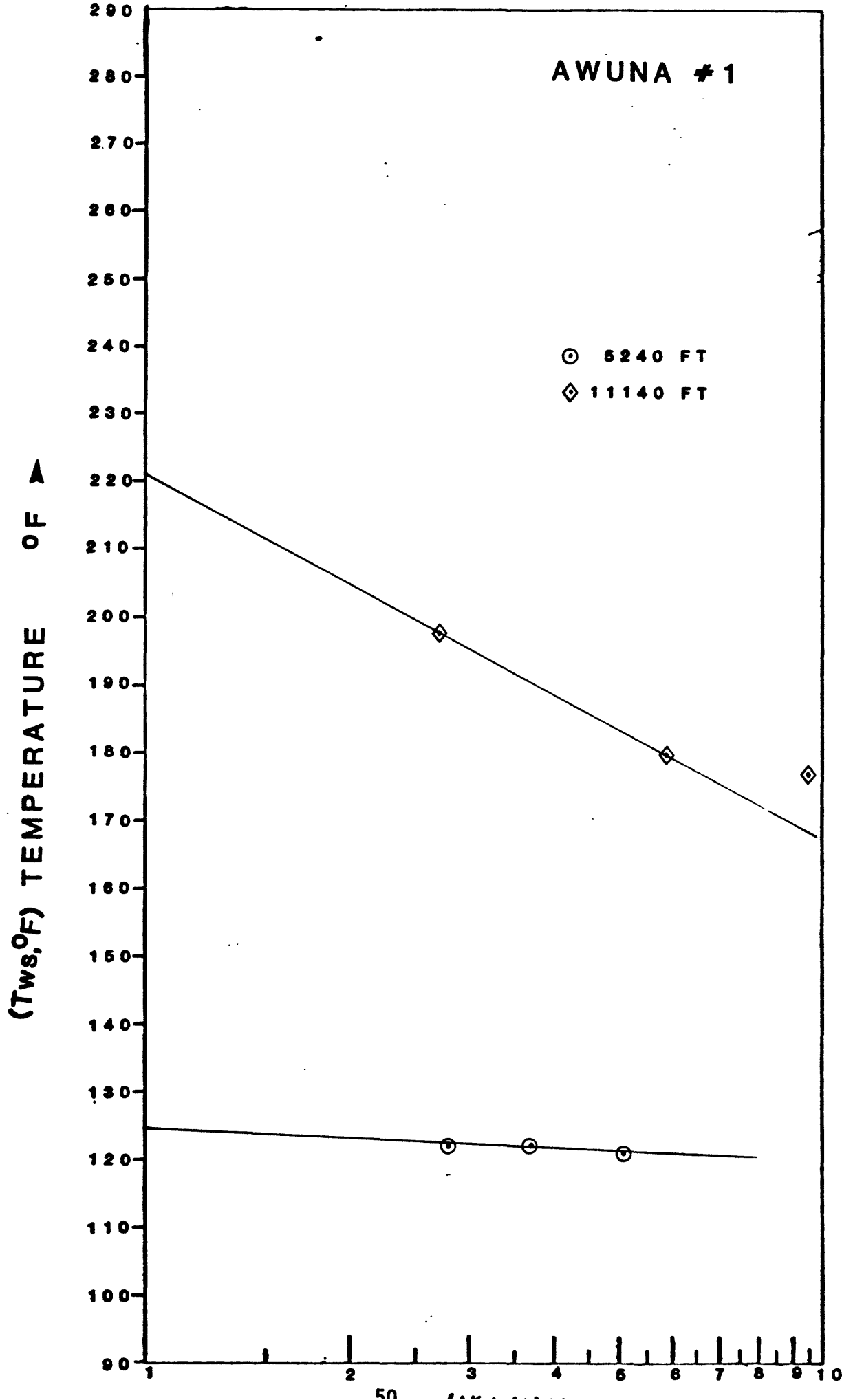
Depth	Date/Time Penetration of Depth	Date/Time Circulation stopped	Date/Time Re-circulation (or core or ream) (1)	Date/Time Re-circulation stopped	Date/Time Re-circulation (or ream) (2)	Date/Time Re-circulation stopped	Total Hours of circulation	Date/Time Logging Tool on Bottom	Hours since last circulation stopped	Log Type	°F Actual Recorded Temperature	Remarks
4348	2/1 2100	2/2 0000	2/2 0200	2/2 0530			6.5	2/2 1130	6	Temp #1	98	
4300	2/1 0830	2/2 0000	2/2 0200	2/2 0530			6.5	2/2 1700	11.5	DLL	100	
4300	2/1 0830	2/2 0000	2/2 0200	2/2 0530			6.5	2/2 2300	17.5	FDL	100	
4300	2/1 0830	2/2 0000	2/2 0200	2/2 0530			6.5	2/3 0230	21	BHC	100	
4300	2/1 0830	2/2 0000	2/2 0200	2/2 0530			6.5	2/3 0630	25	HRD	100	
4354	2/1 2130	2/2 0000	2/2 0200	2/2 0530			6.5	2/3 1330	32	Temp #2	103	

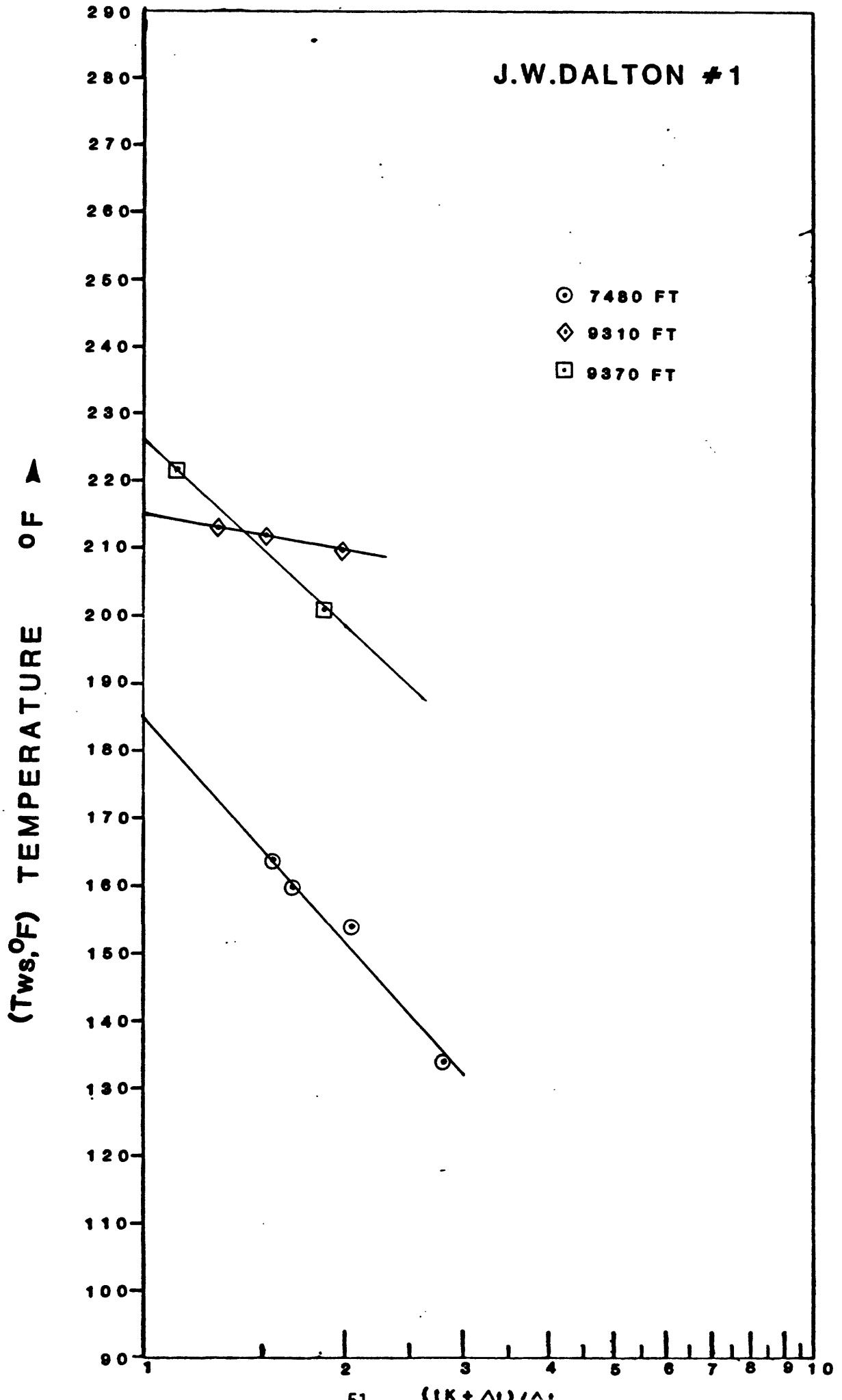
Appendix 2

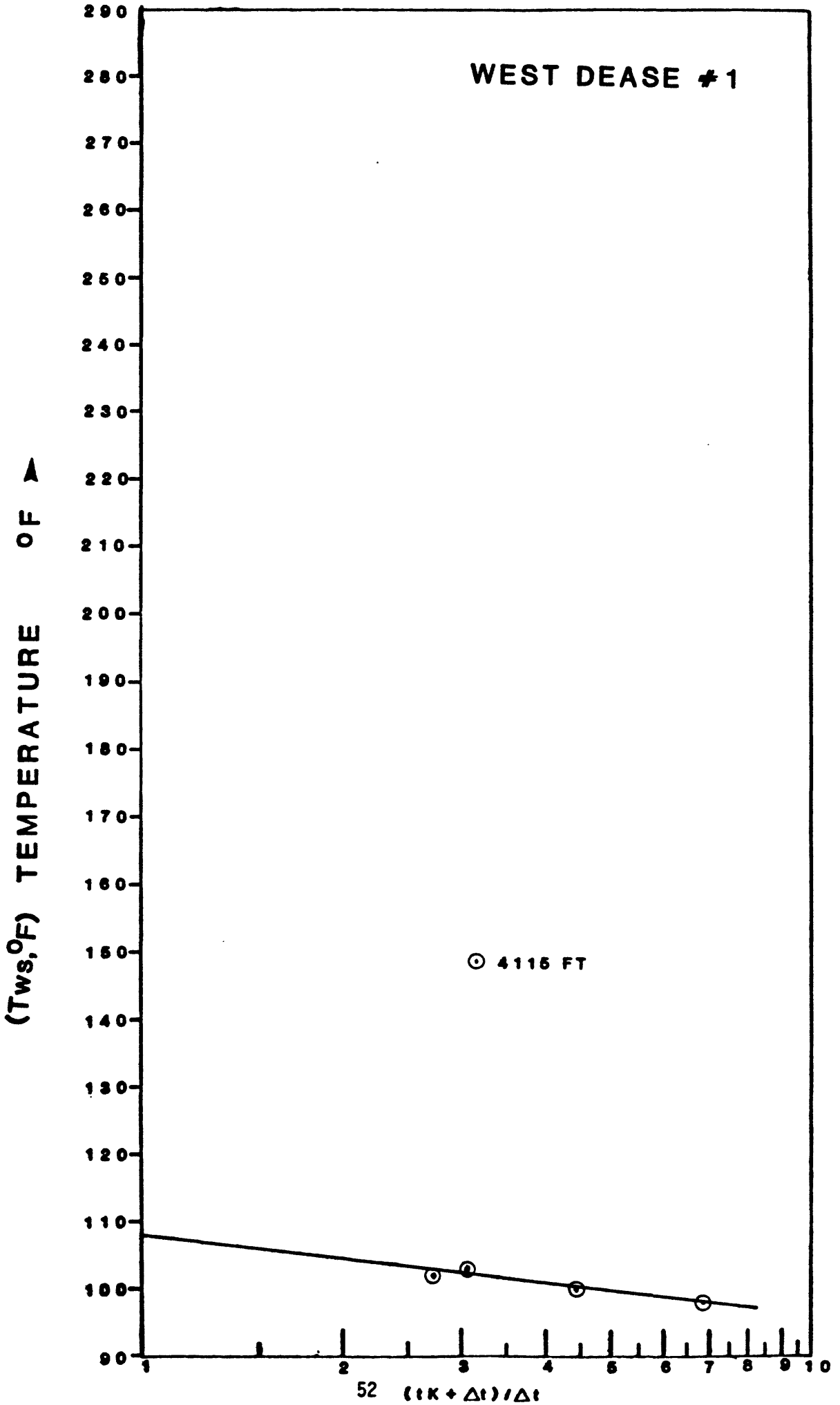
PLOTS OF EXTRAPOLATED TEMPERATURES

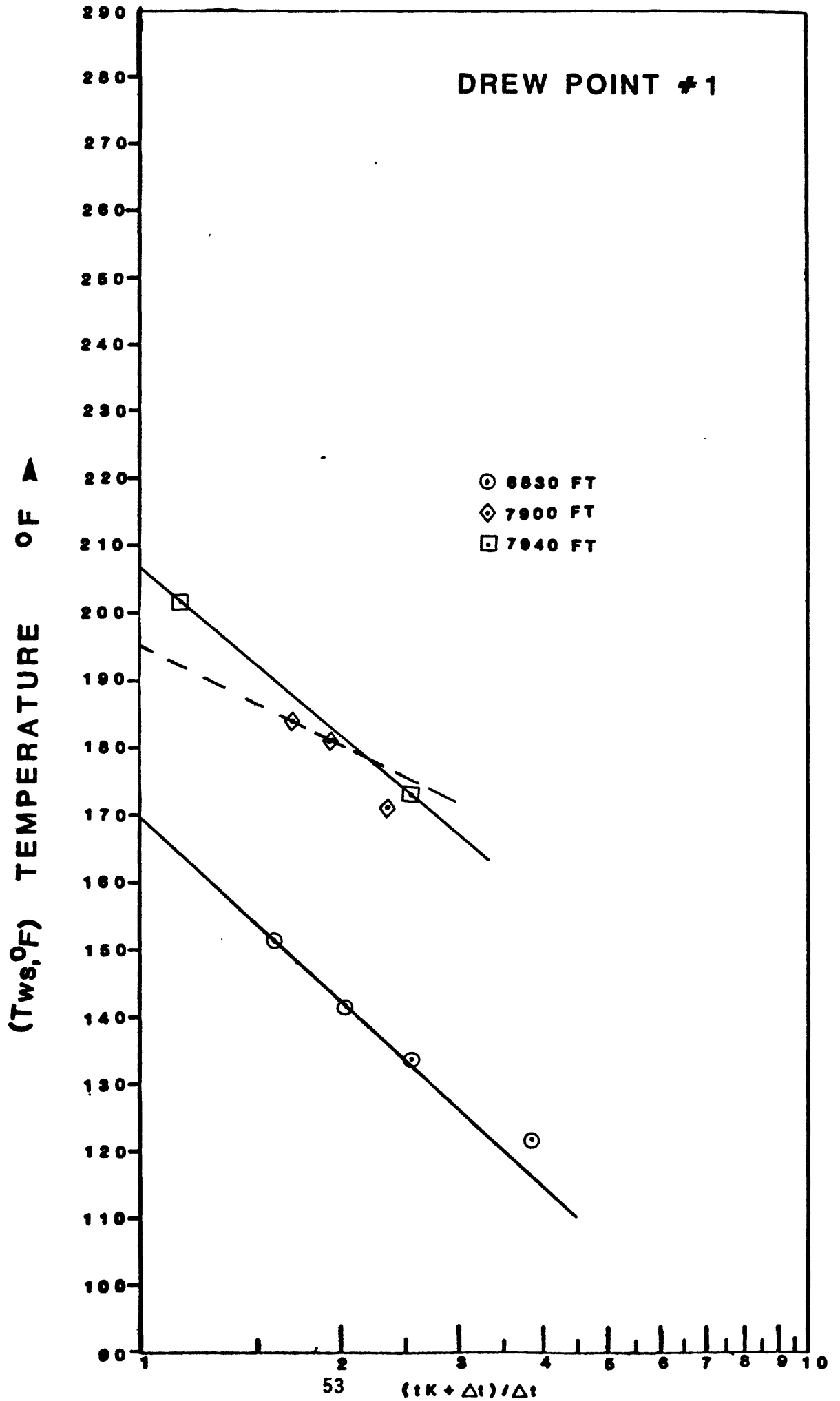
The method of a modified Horner Plot to extrapolate undisturbed temperatures was found to be generally applicable to wells in NPRA. Dashed extrapolation lines indicate some uncertainty in our plotting, but these extrapolated undisturbed temperatures are certainly reliable within limits of the method.

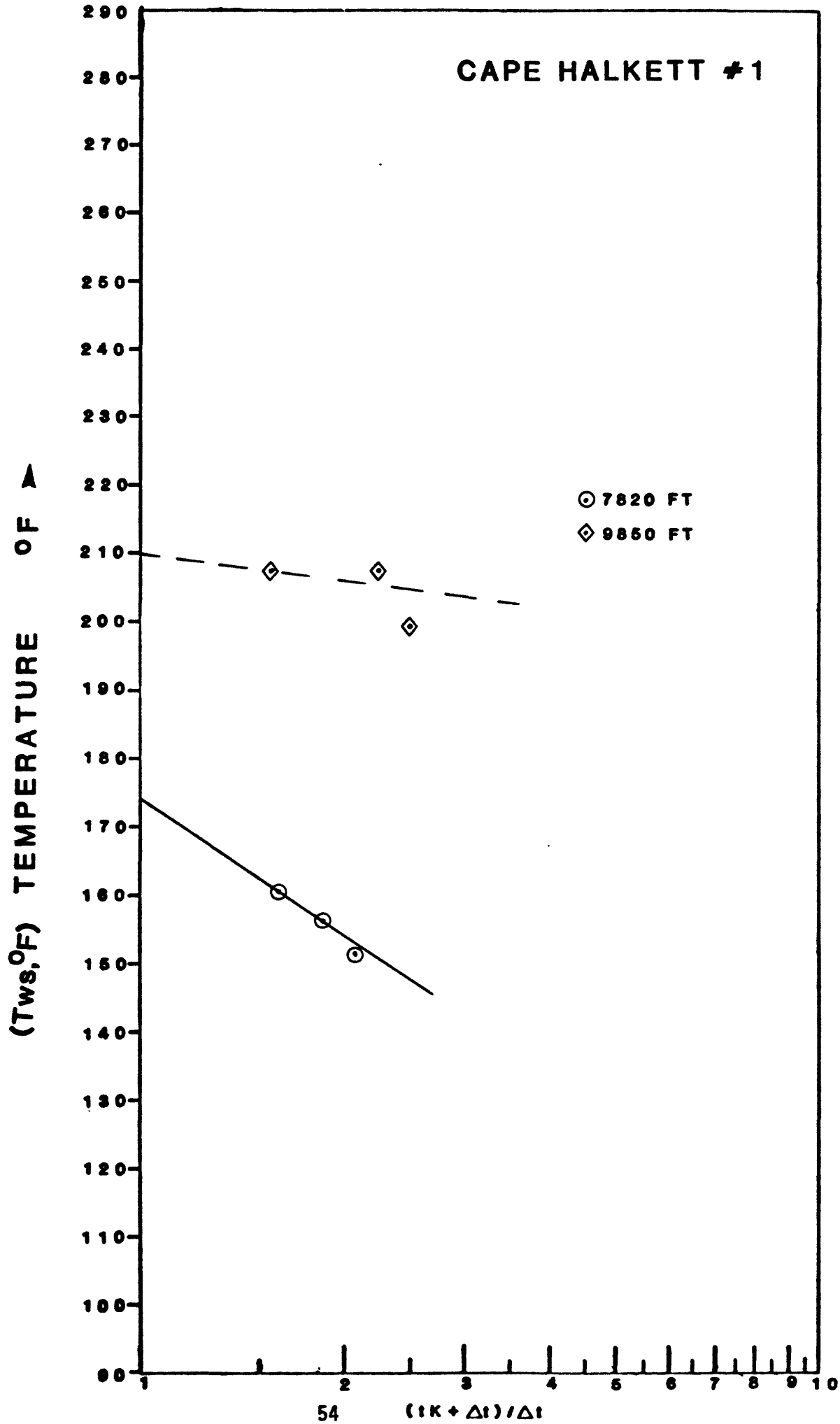

ATIGARU POINT #1
(Tws,°F) TEMPERATURE OF
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt
8100 FT
11480 FT

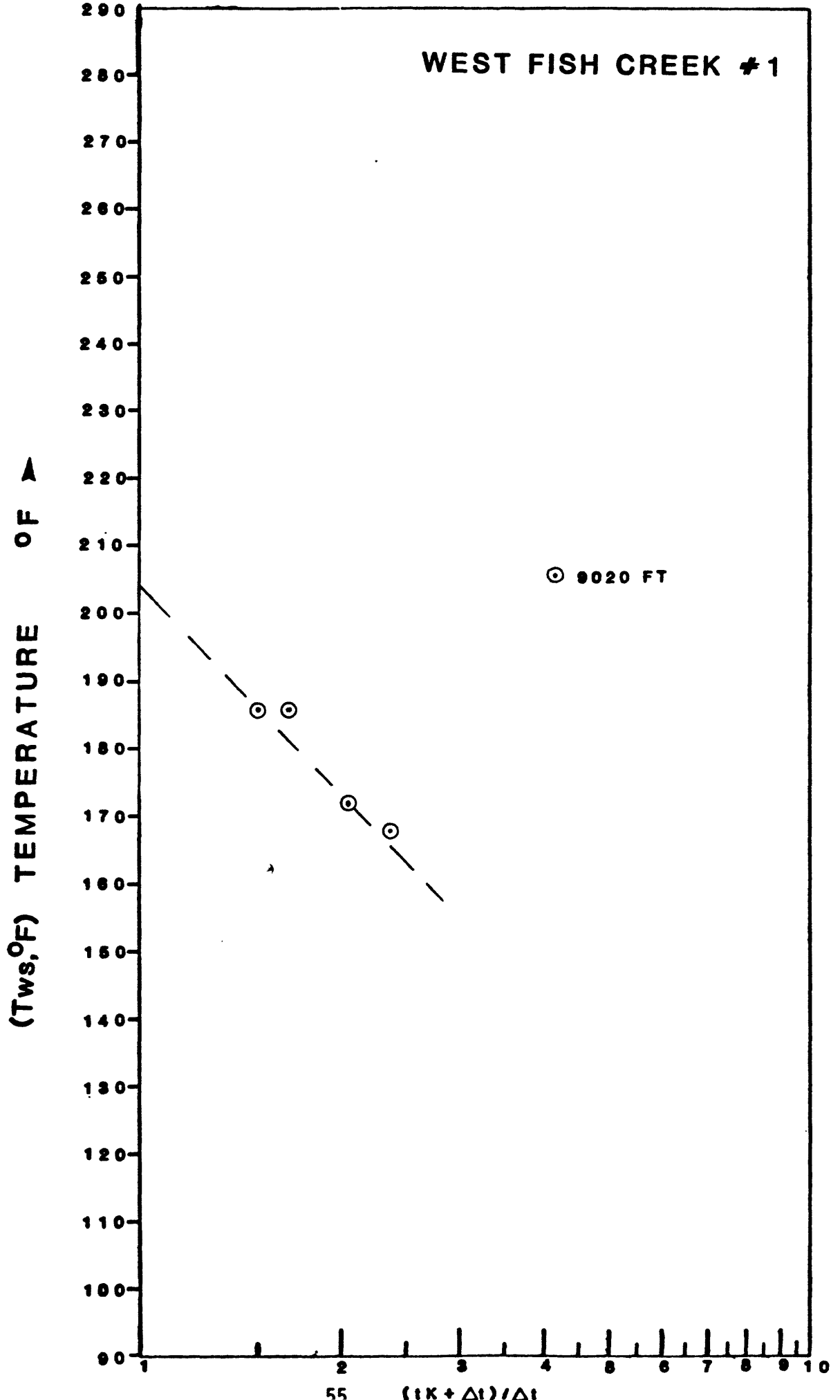

AWUNA #1
5240 FT
11140 FT
(Tws,°F) TEMPERATURE °F
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10

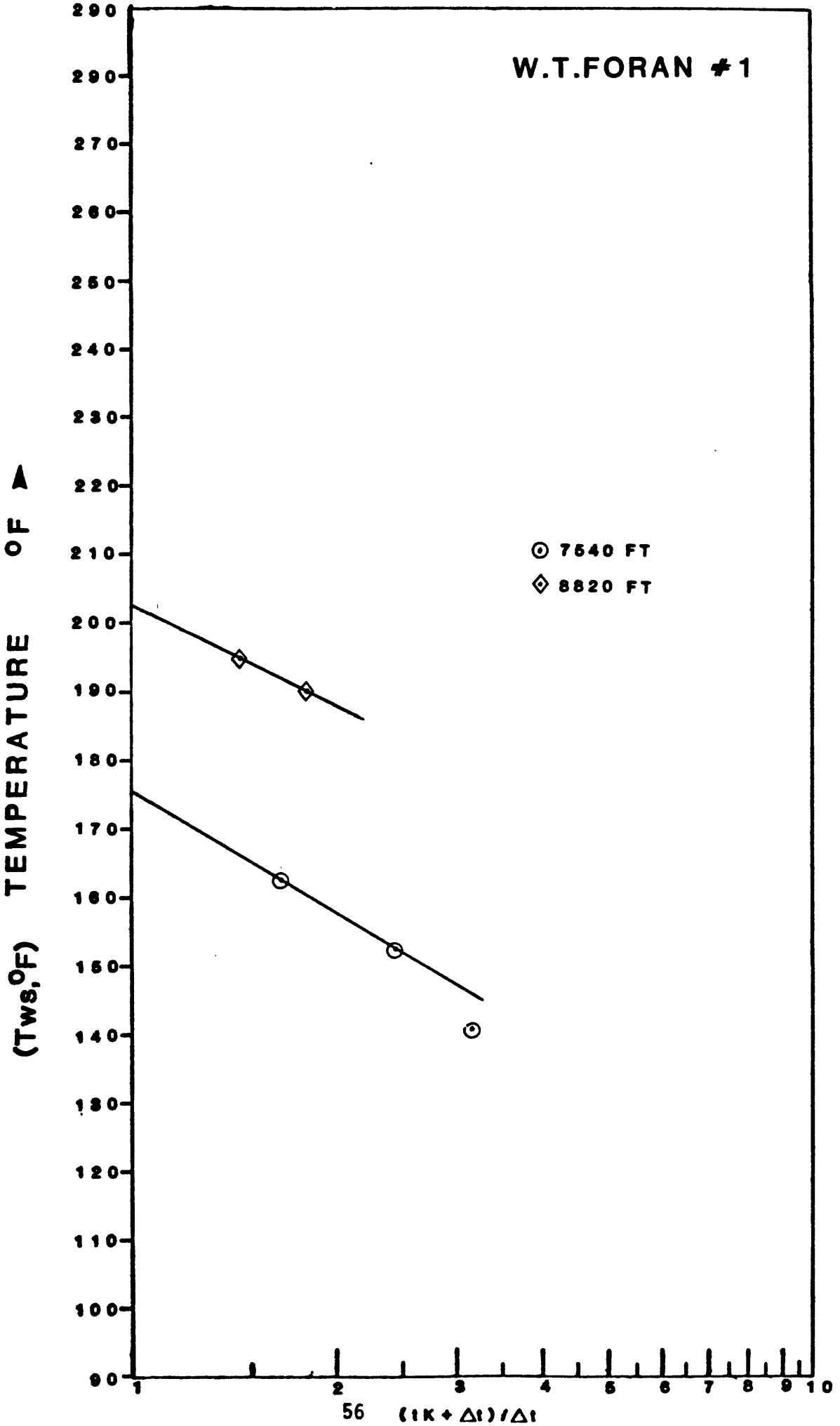

J.W.DALTON #1
7480 FT
9310 FT
9370 FT
(Tws,°F) TEMPERATURE OF
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10

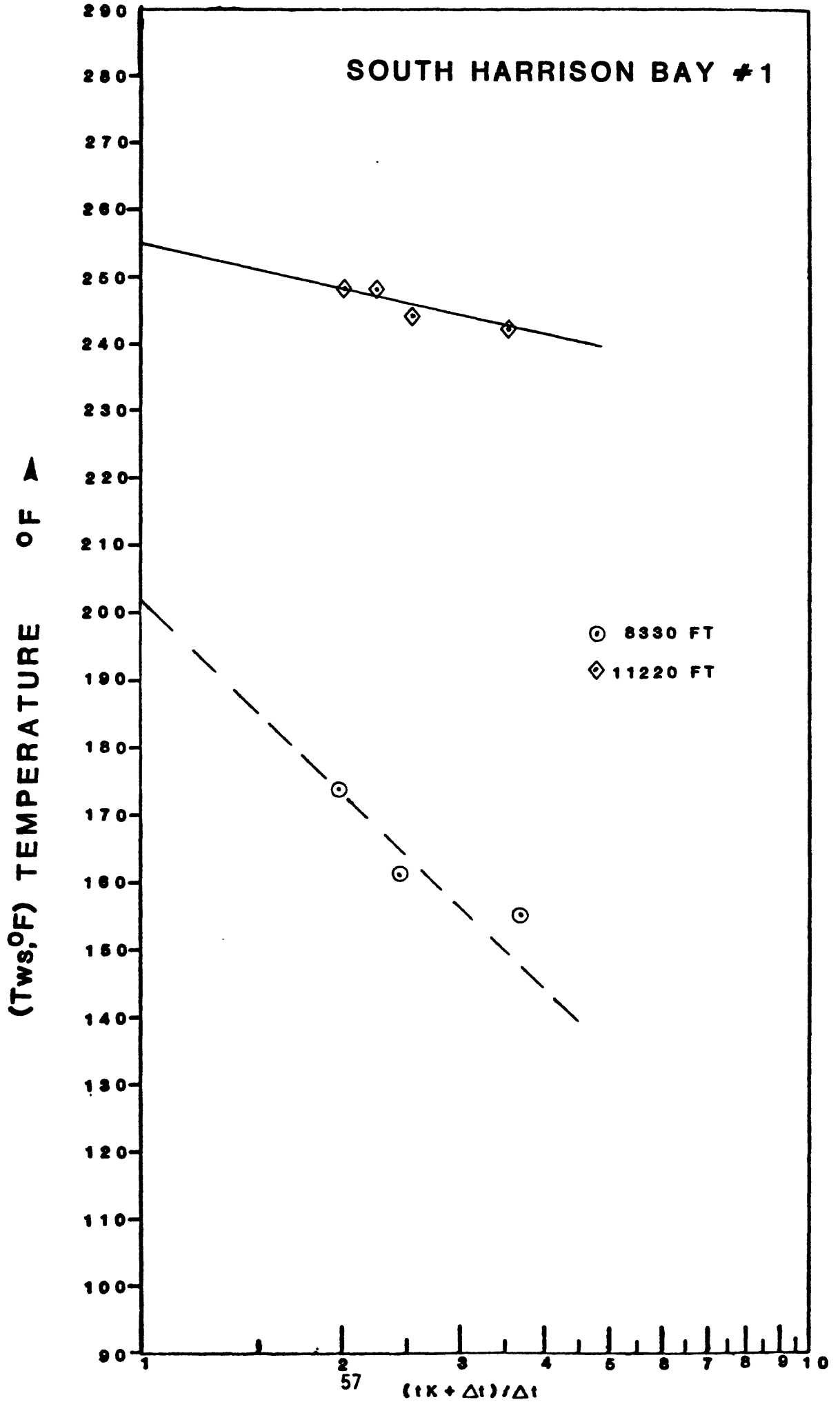

WEST DEASE #1
4115 FT
(Tws,°F) TEMPERATURE OF
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt

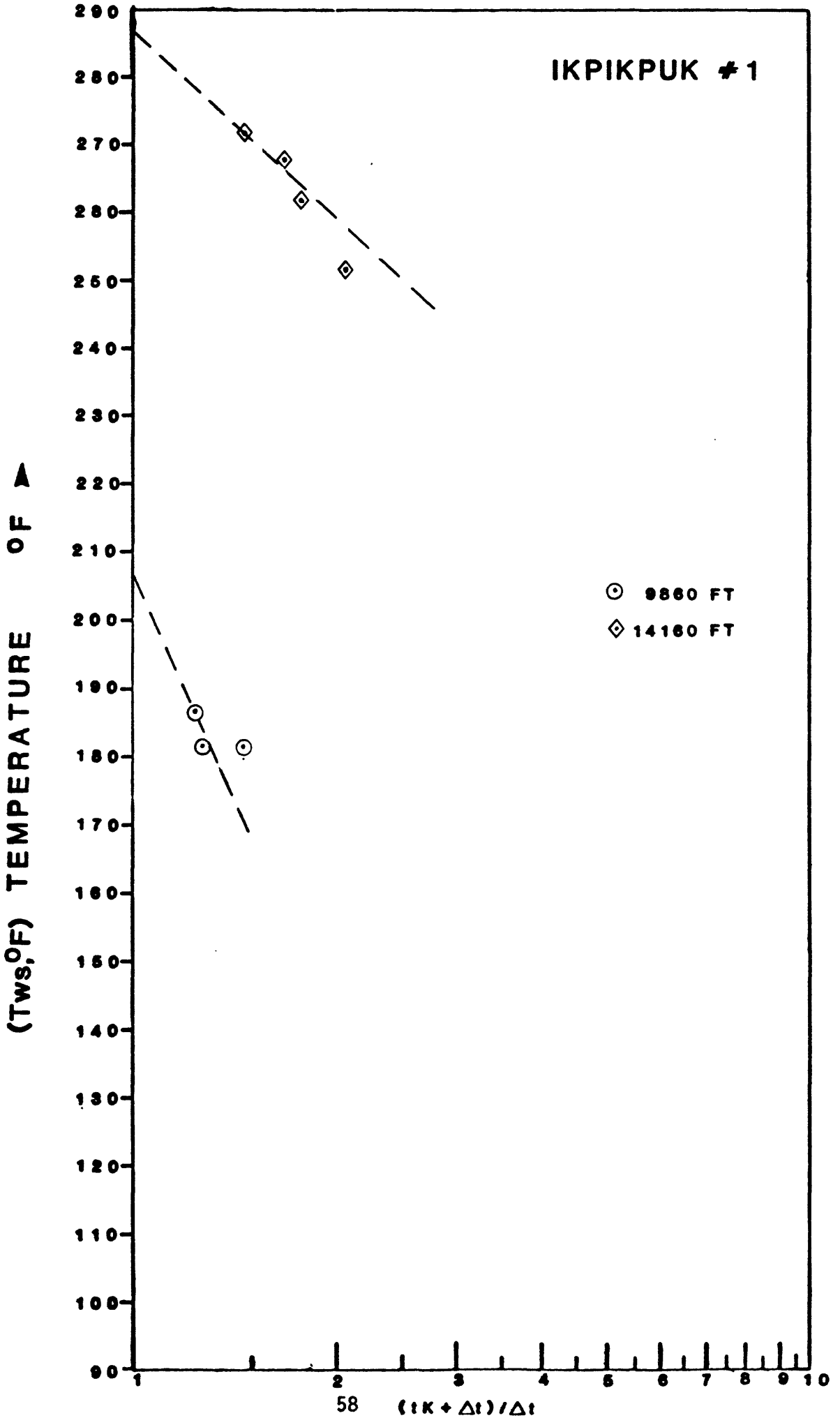

DREW POINT #1
6830 FT
7900 FT
7940 FT
(Tws,°F) TEMPERATURE OF A
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt) / Δt

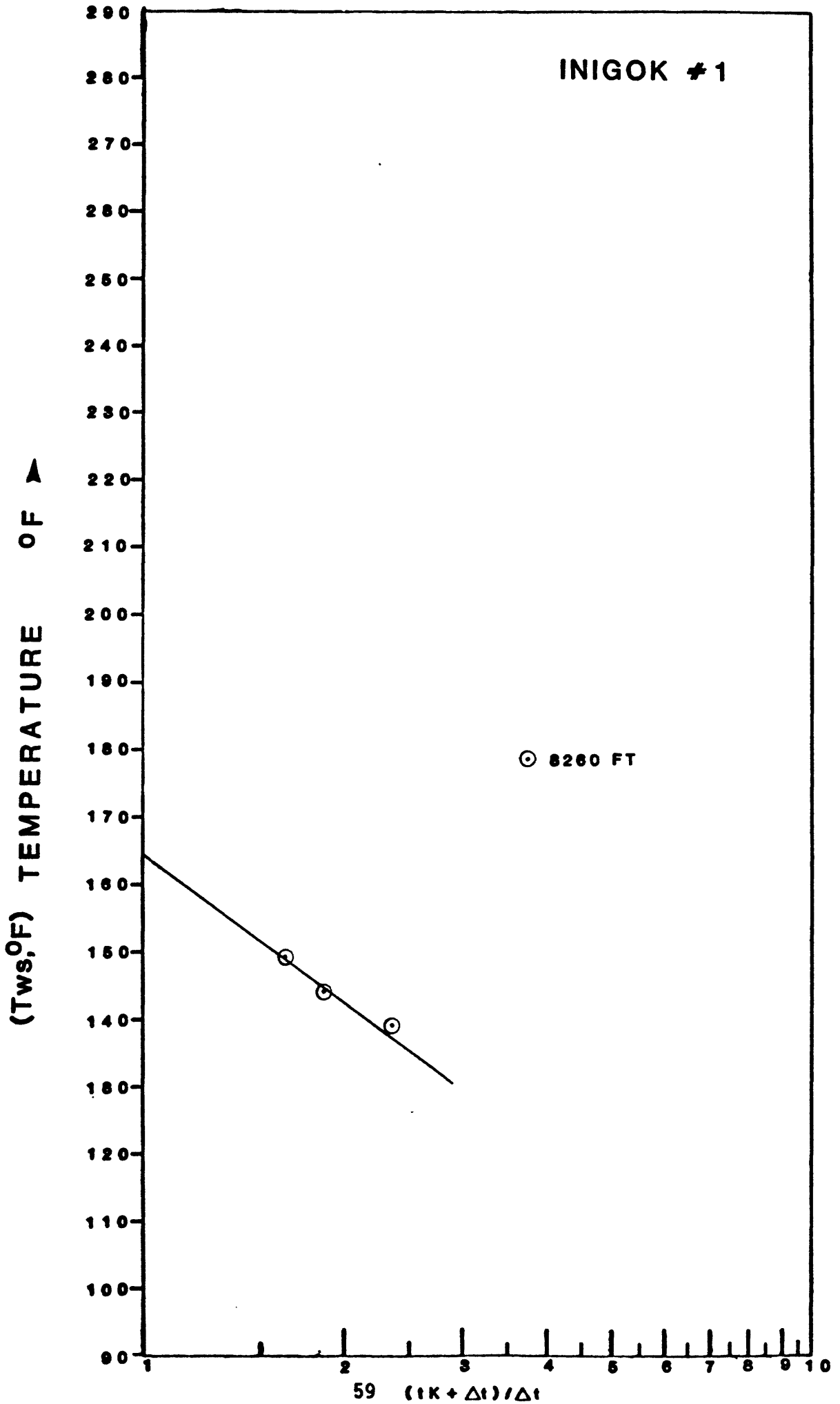

CAPE HALKETT #1
7820 FT
9850 FT
(Tws,°F) TEMPERATURE OF ▲
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt) / Δt


WEST FISH CREEK #1
9020 FT
(Tws,°F) TEMPERATURE °F
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt

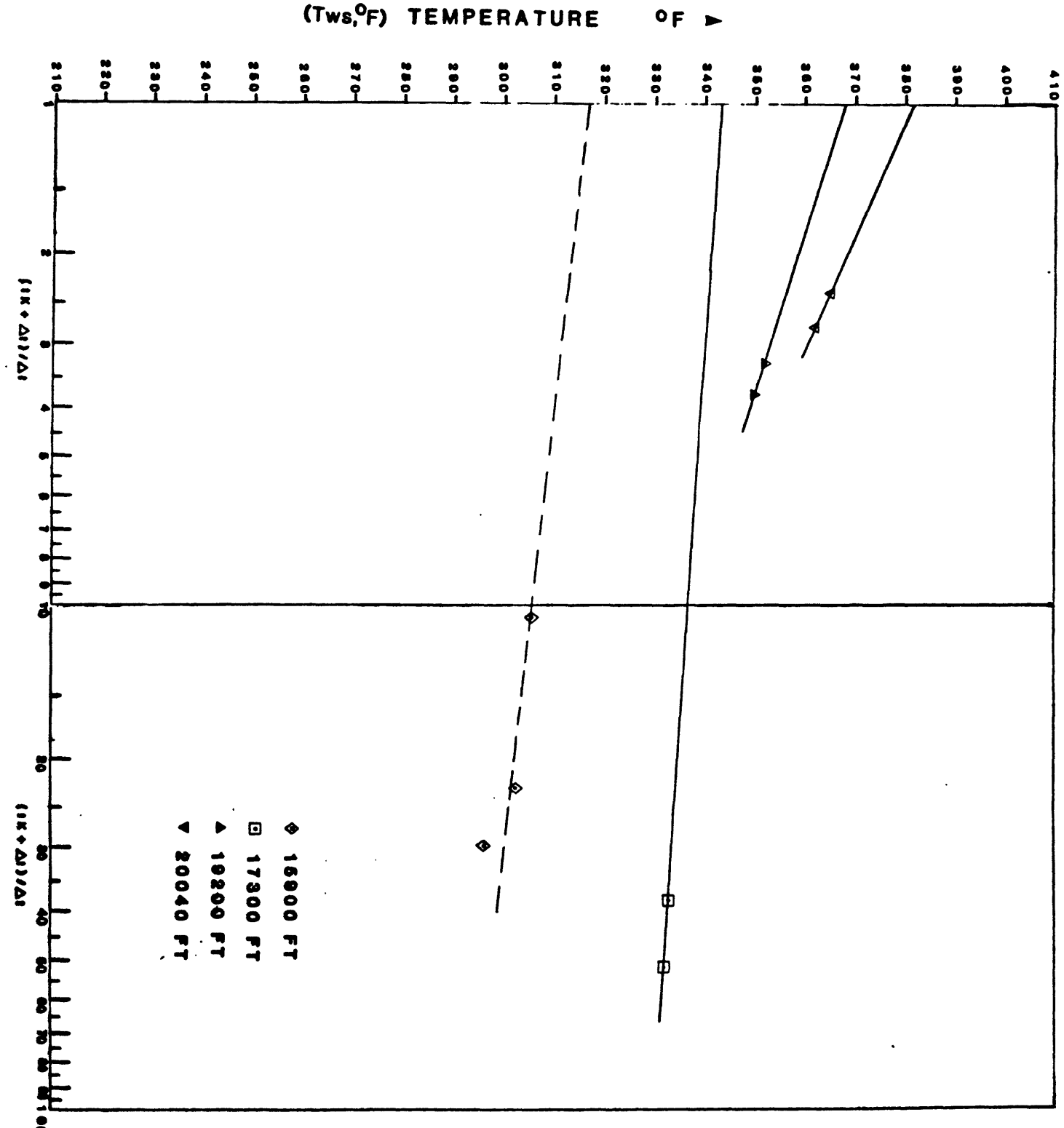

W.T.FORAN #1
⊙ 7540 FT
◇ 8820 FT
(Tws,°F) TEMPERATURE °F ▲
290
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt

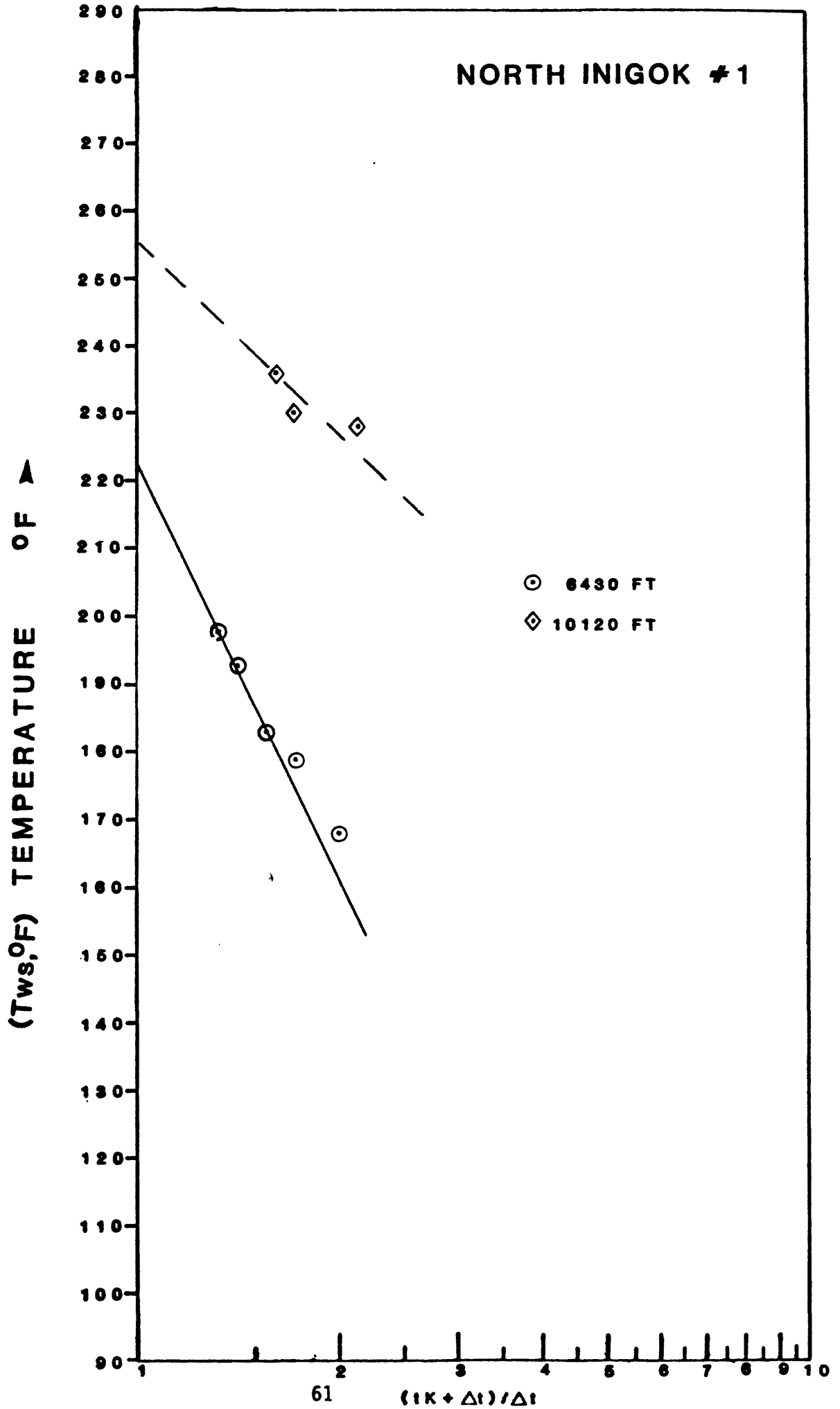

SOUTH HARRISON BAY #1
(Tws,°F) TEMPERATURE OF
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
8330 FT
11220 FT
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt

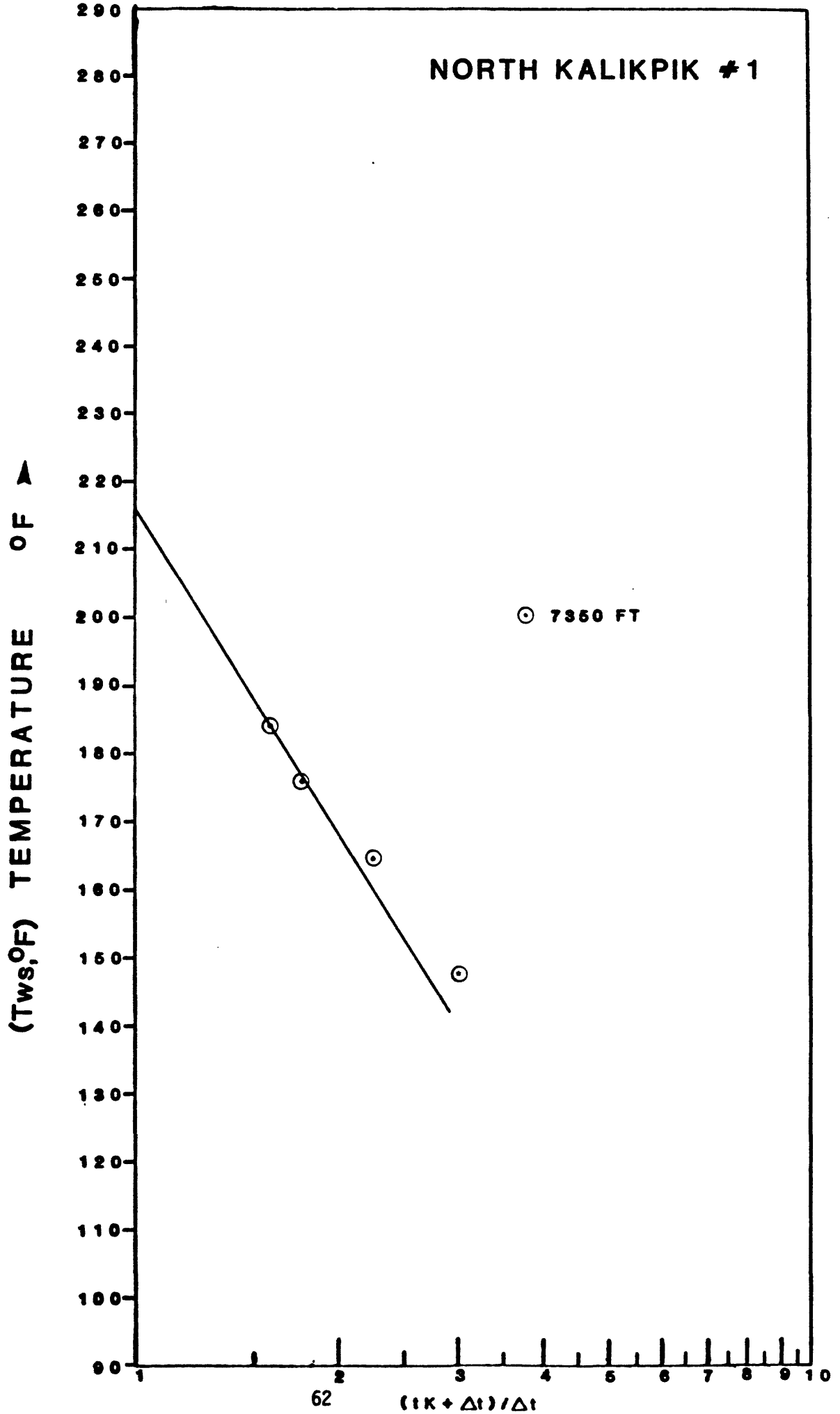

IKPIKPUK #1
(Tws,°F) TEMPERATURE OF ▲
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
9860 FT
14160 FT
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt

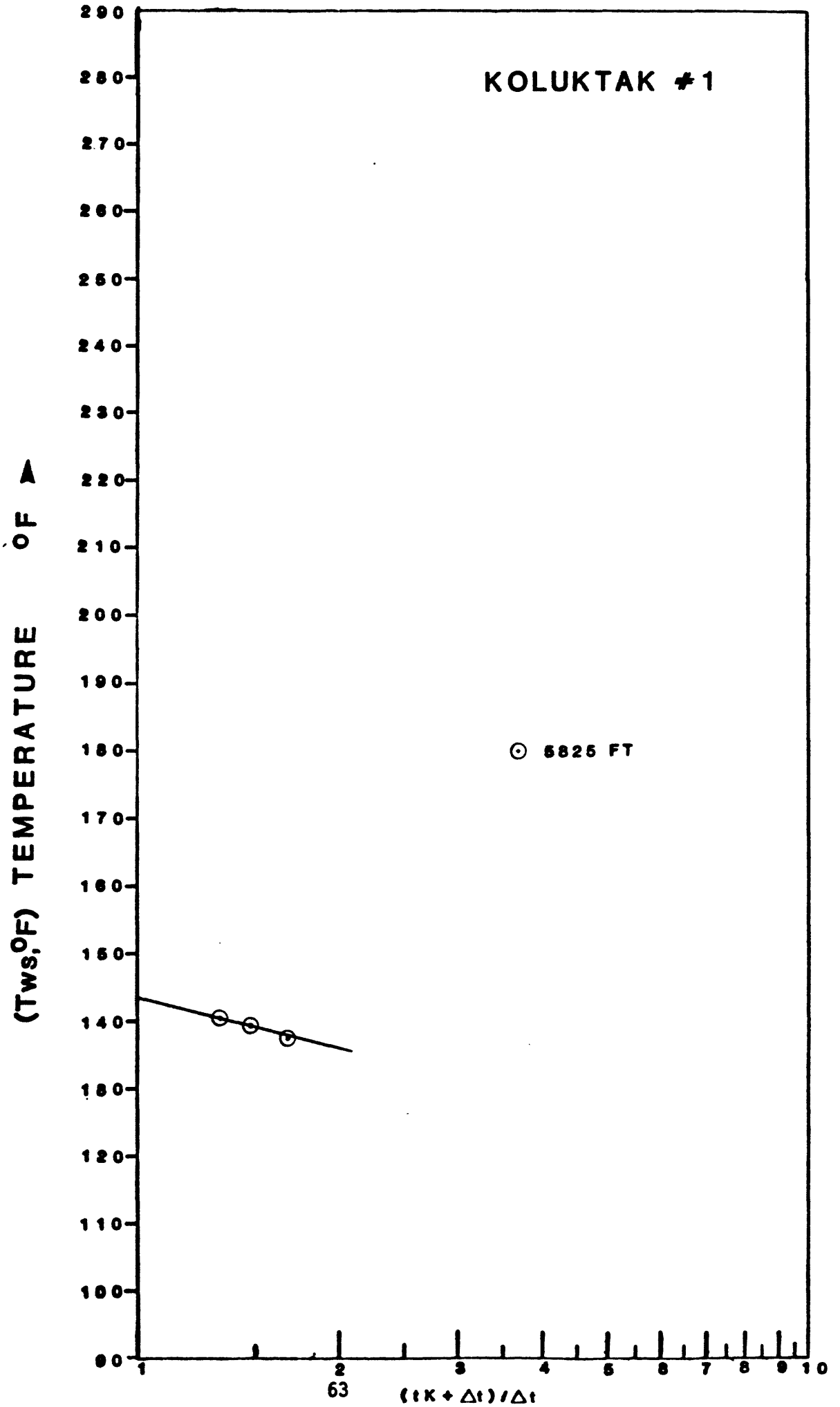

INIGOK #1
⊙ 8260 FT
(Tws,°F) TEMPERATURE OF ▲
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(1K + Δt)/Δt

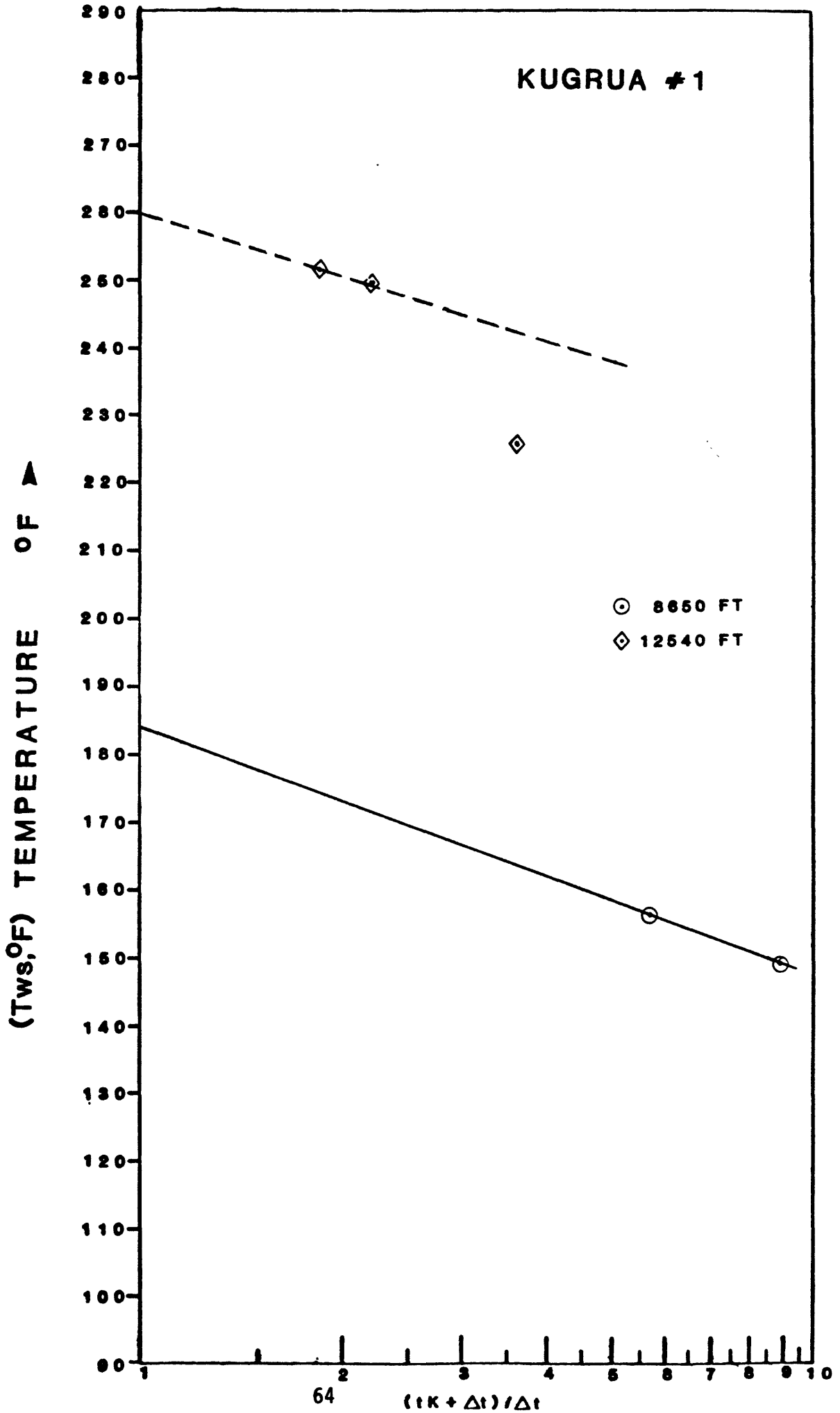
INIGOK #1


(Tws,°F) TEMPERATURE °F ►
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
16900 FT
17300 FT
19200 FT
20040 FT


NORTH INIGOK #1
6430 FT
10120 FT
(Tws,°F) TEMPERATURE OF
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt


NORTH KALIKPIK #1
⊙ 7350 FT
(Tws,°F) TEMPERATURE OF ▲
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt


KOLUKTAK #1
⊙ 5825 FT
(Tws,°F) TEMPERATURE °F
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
180
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt) / Δt


KUGRUA #1
8650 FT
12540 FT
(Tws,°F) TEMPERATURE OF A
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
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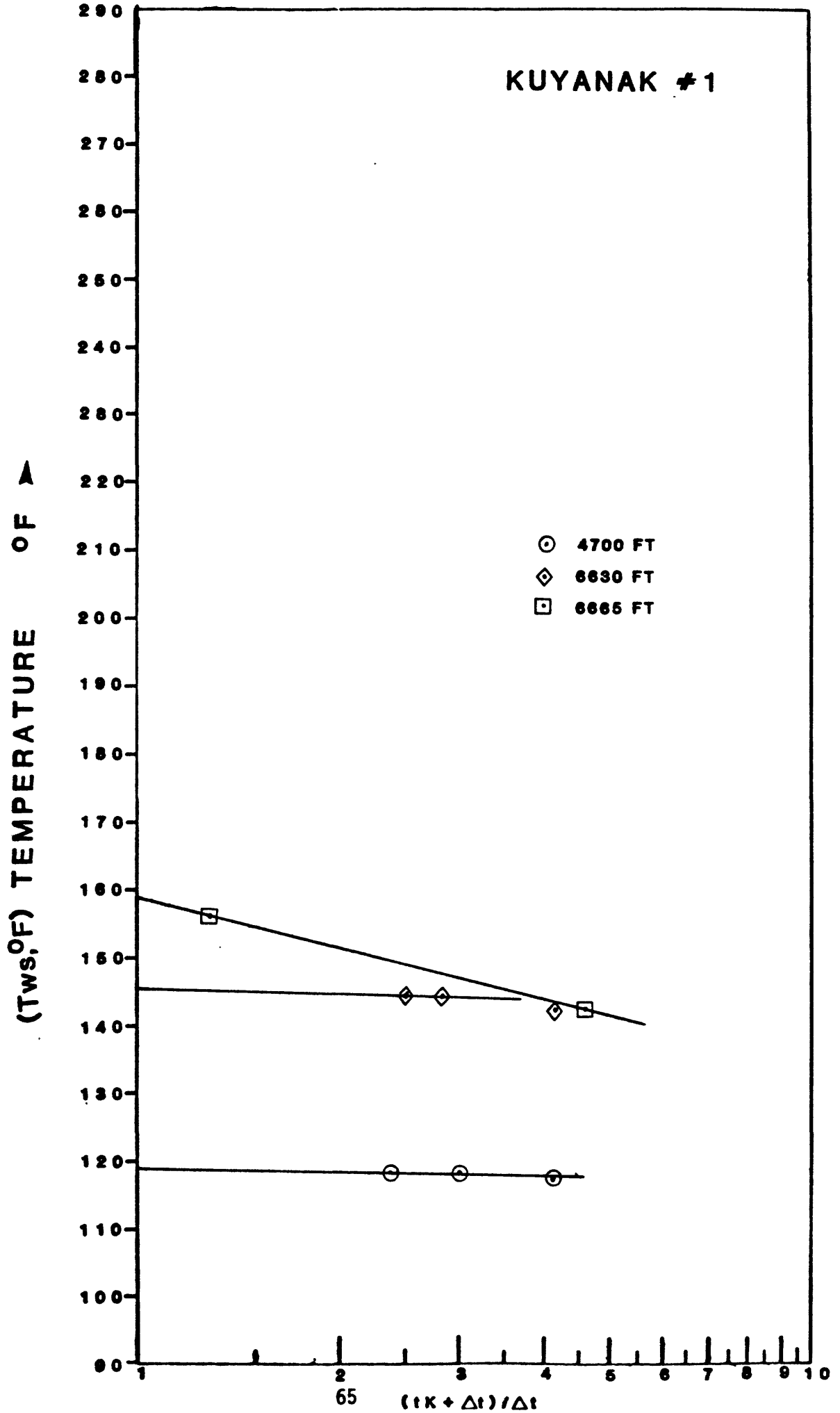
6
7
8
9
10
(tK + Δt)/Δt


KUYANAK #1
4700 FT
6630 FT
6665 FT
(Tws,°F) TEMPERATURE °F
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
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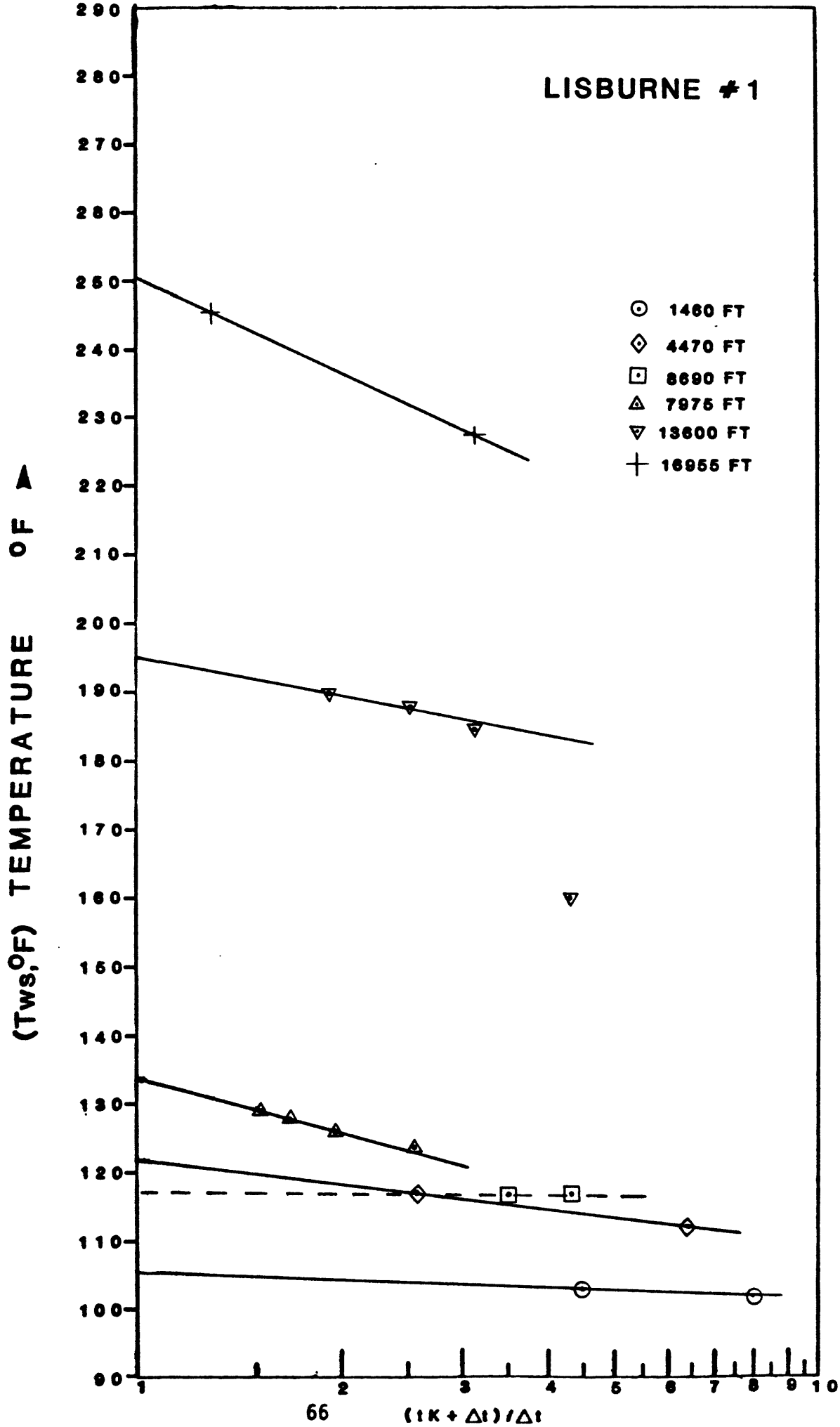
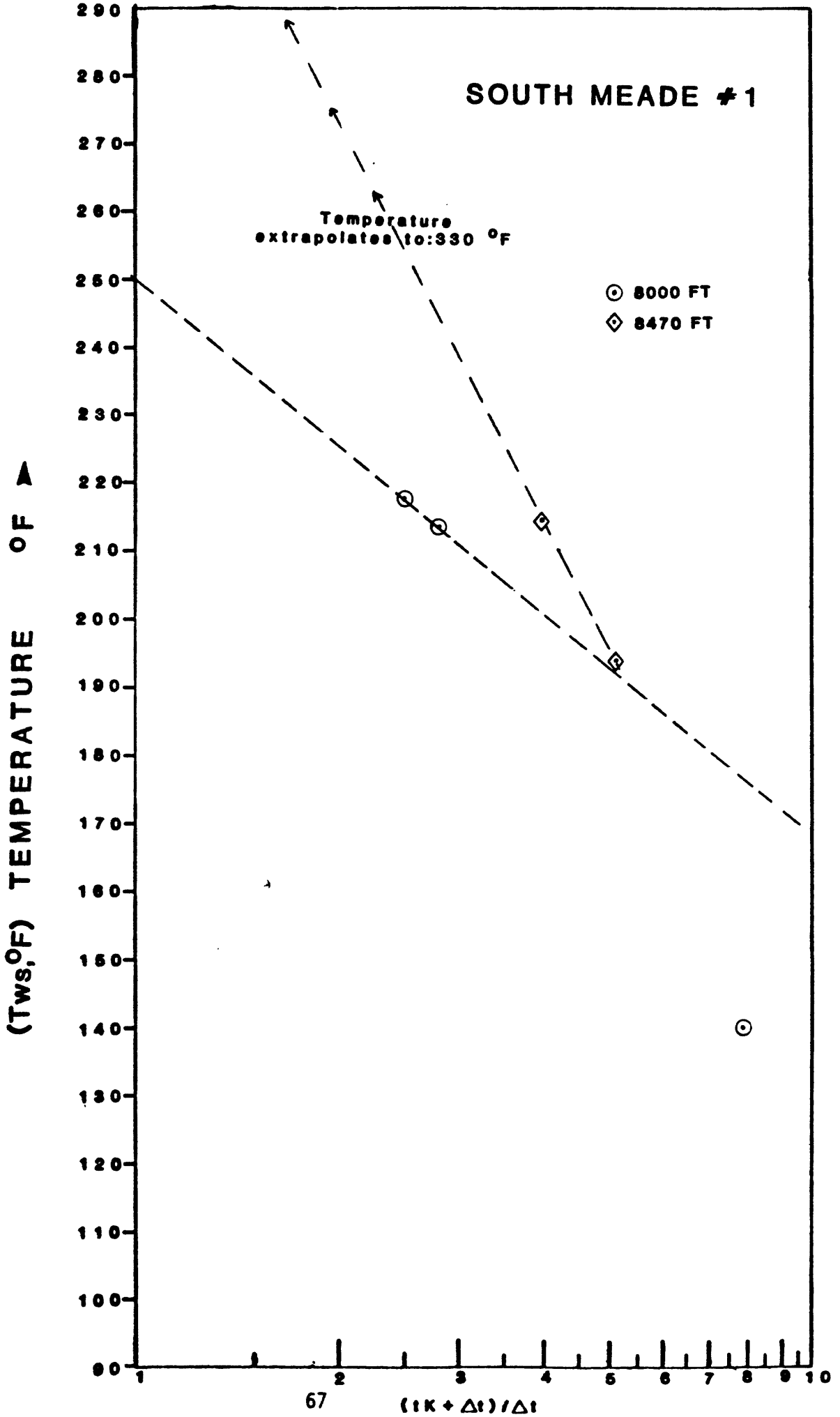
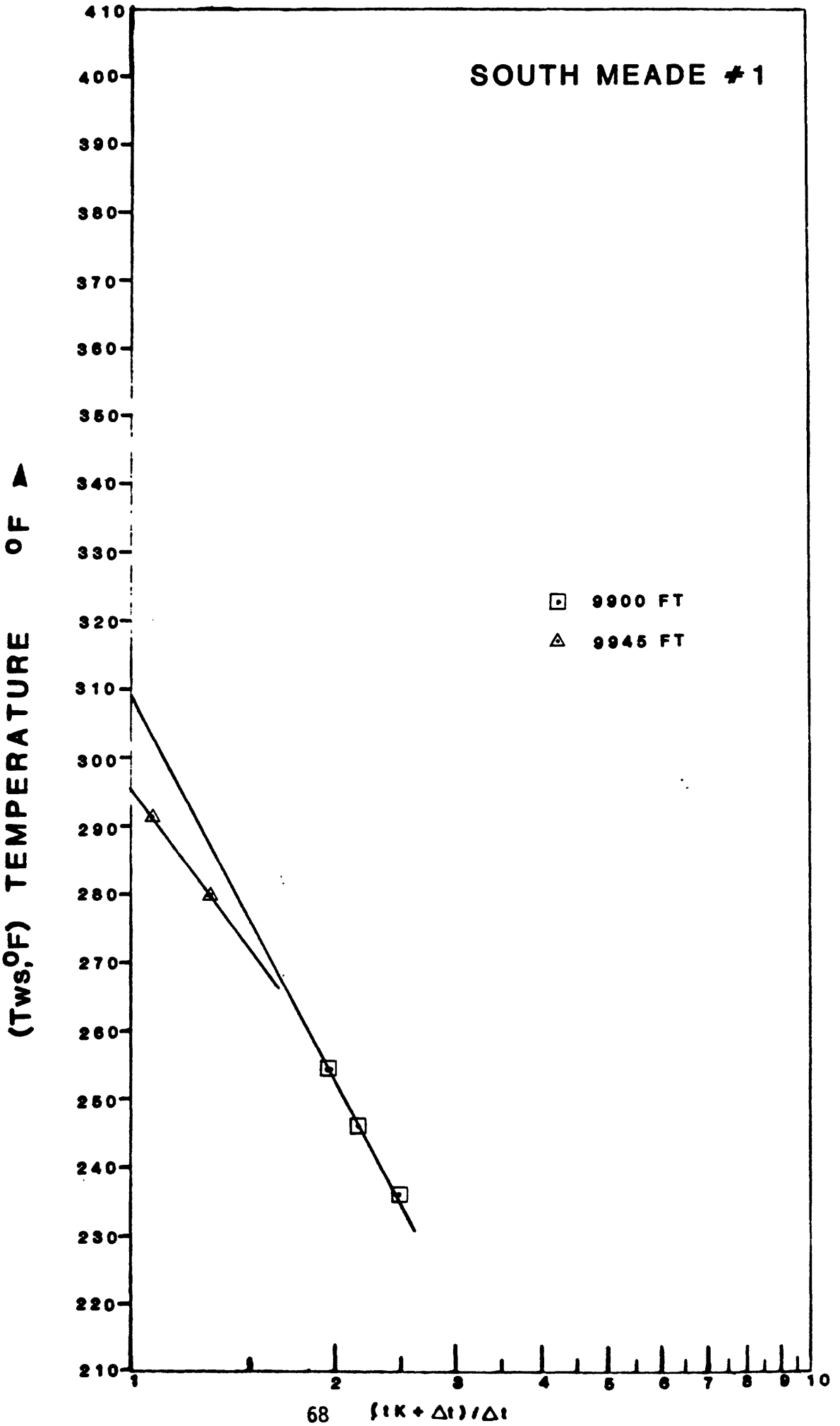
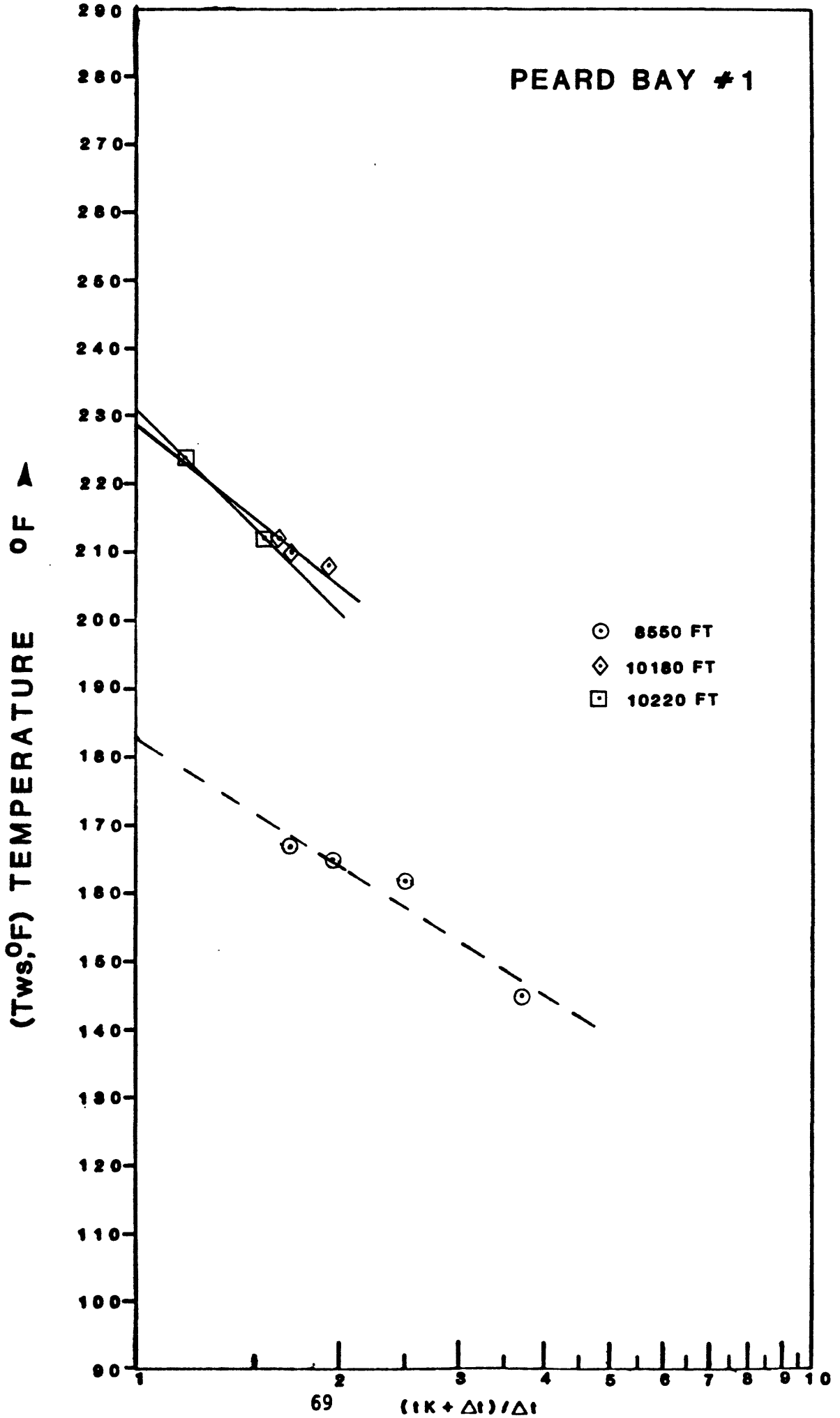
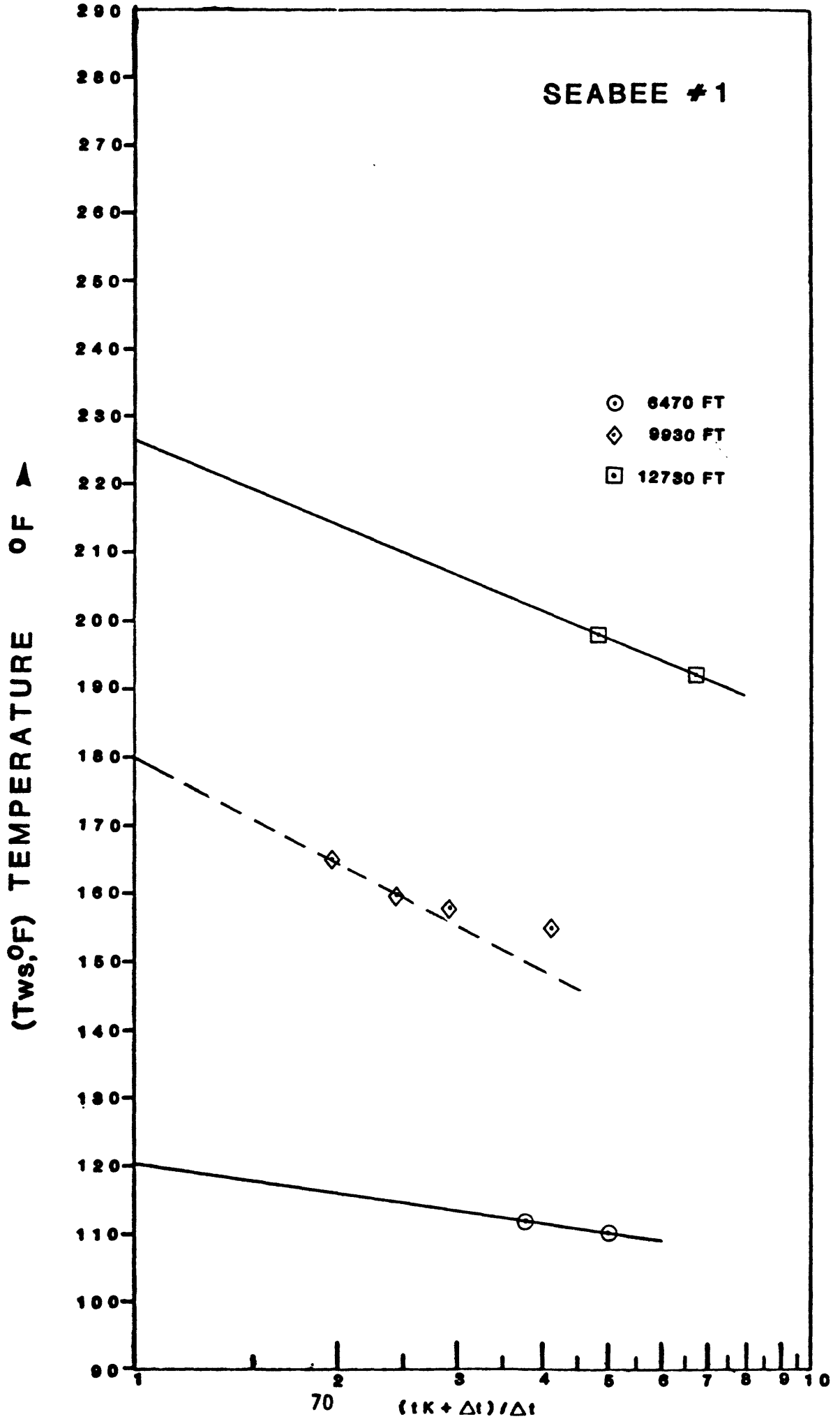
5
6
7
8
9
10
(tK + Δt) / Δt

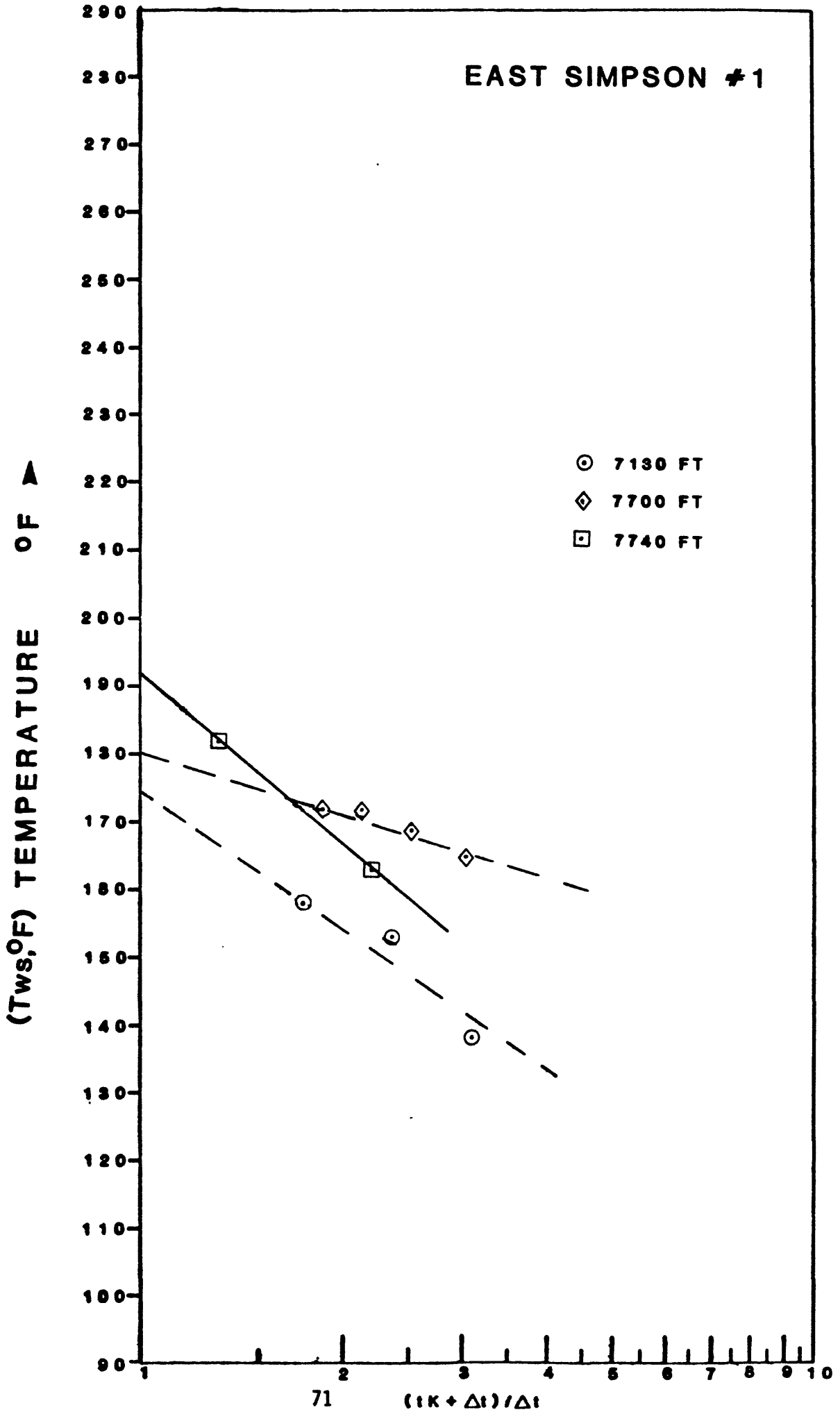

LISBURNE #1
1460 FT
4470 FT
8690 FT
7975 FT
13600 FT
16955 FT
(Tws,°F) TEMPERATURE OF ▲
290
280
270
280
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt

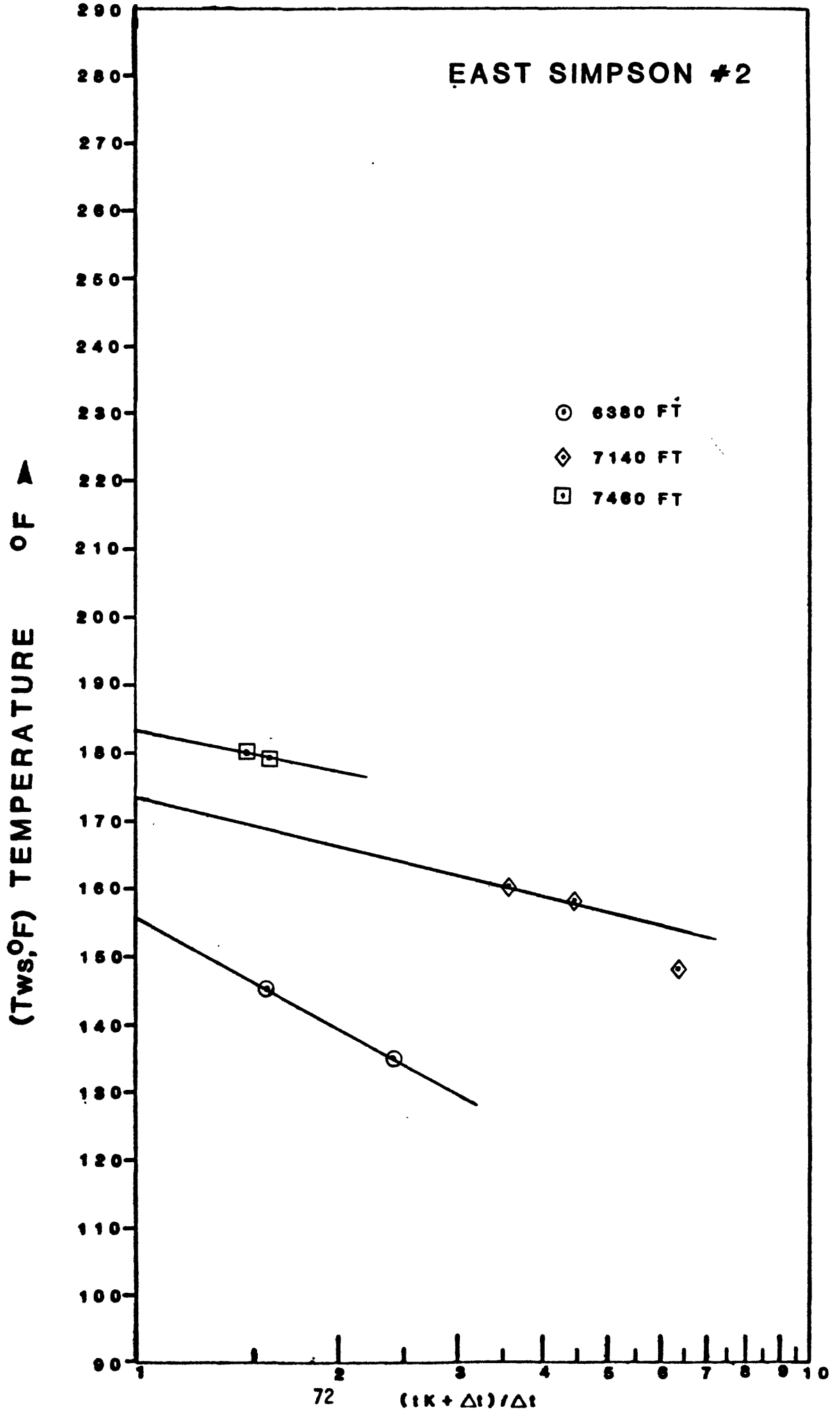

SOUTH MEADE #1
Temperature extrapolates to:330 °F
8000 FT
8470 FT
(Tws,°F) TEMPERATURE °F ▲
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt) / Δt

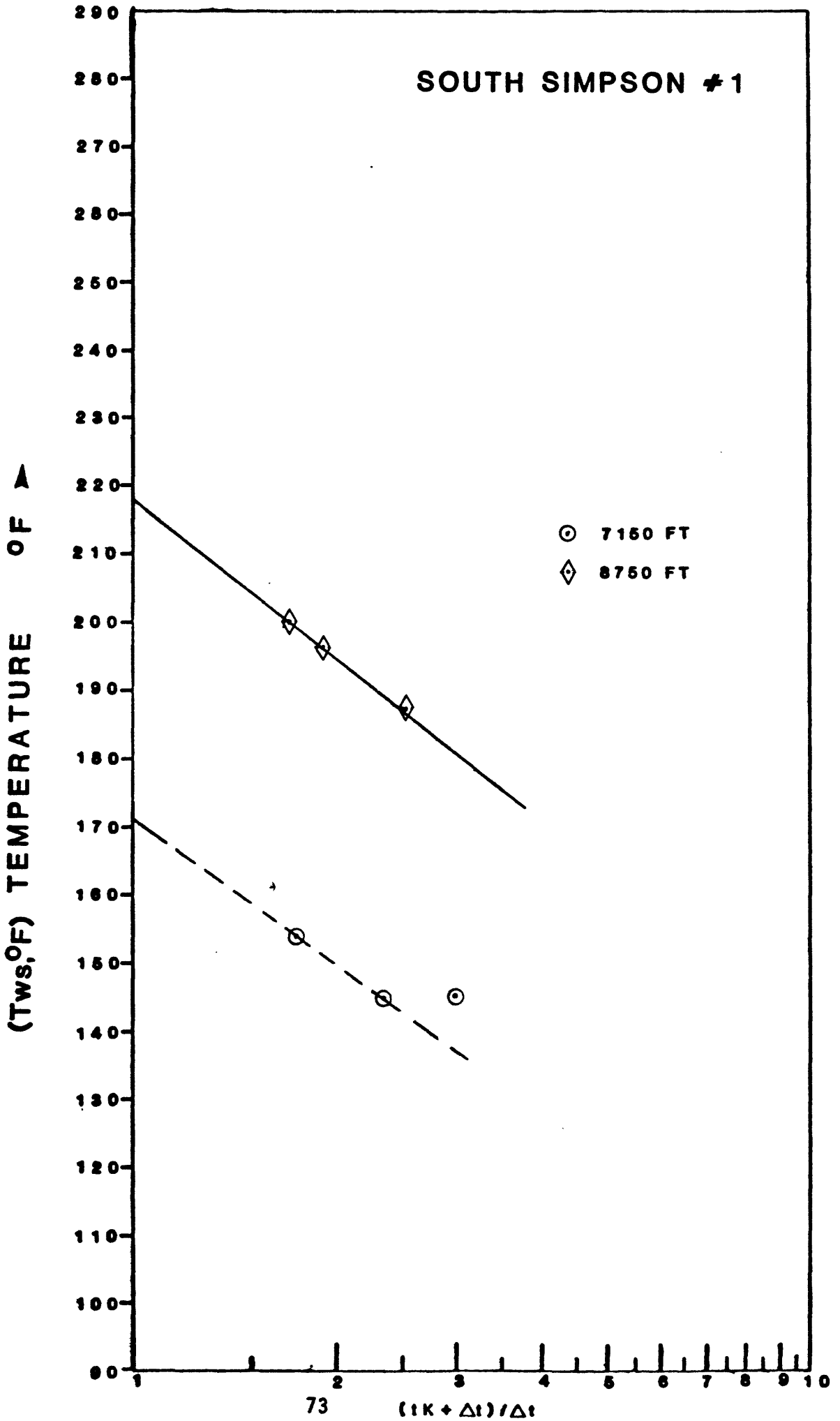

SOUTH MEADE #1
9900 FT
9945 FT
(Tws,°F) TEMPERATURE OF
410
400
390
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
1
2
3
4
5
6
7
8
9
10
(t K + Δt) / Δt

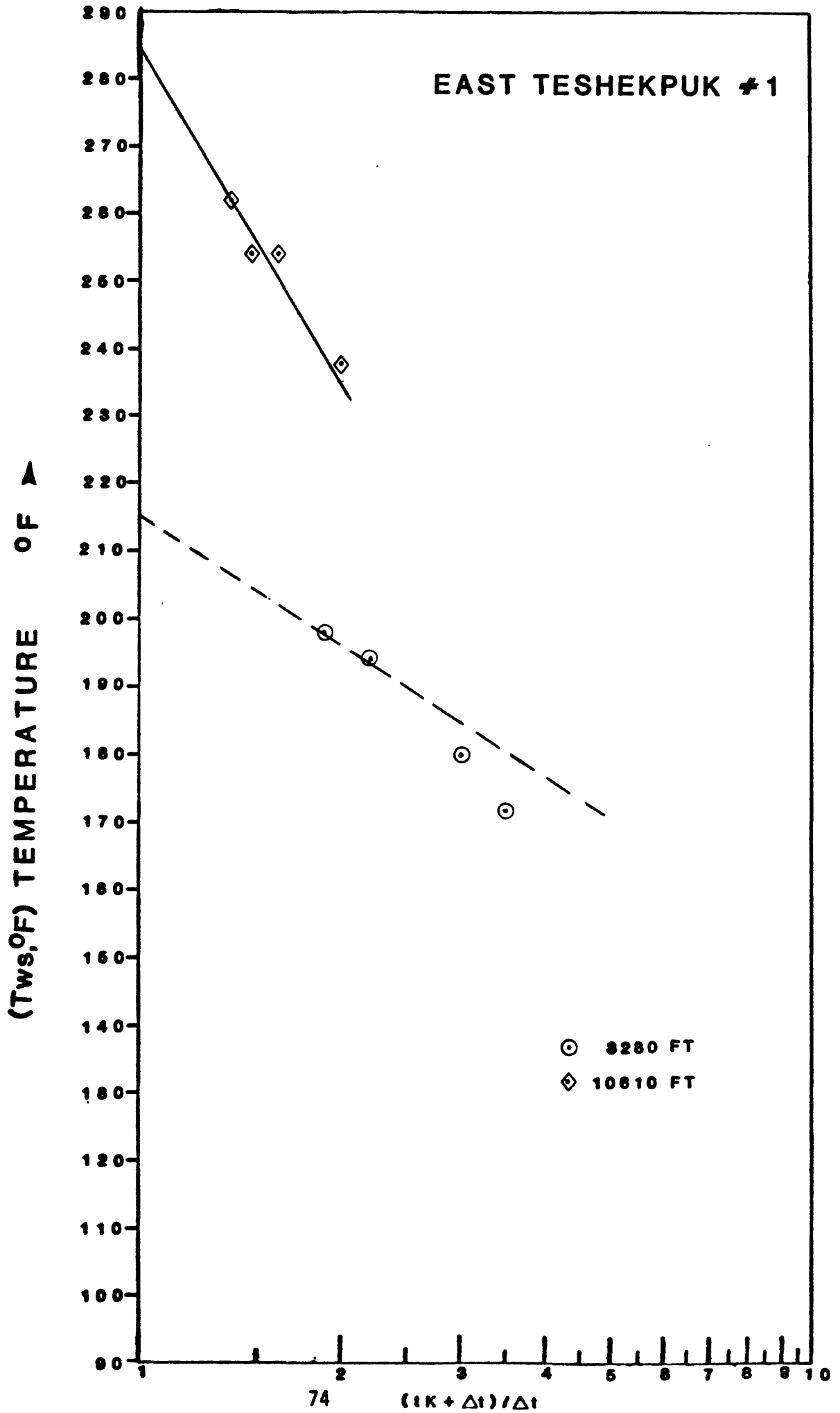

PEARD BAY #1
8550 FT
10180 FT
10220 FT
(Tws,°F) TEMPERATURE OF ▲
(tK + Δt)/Δt
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10

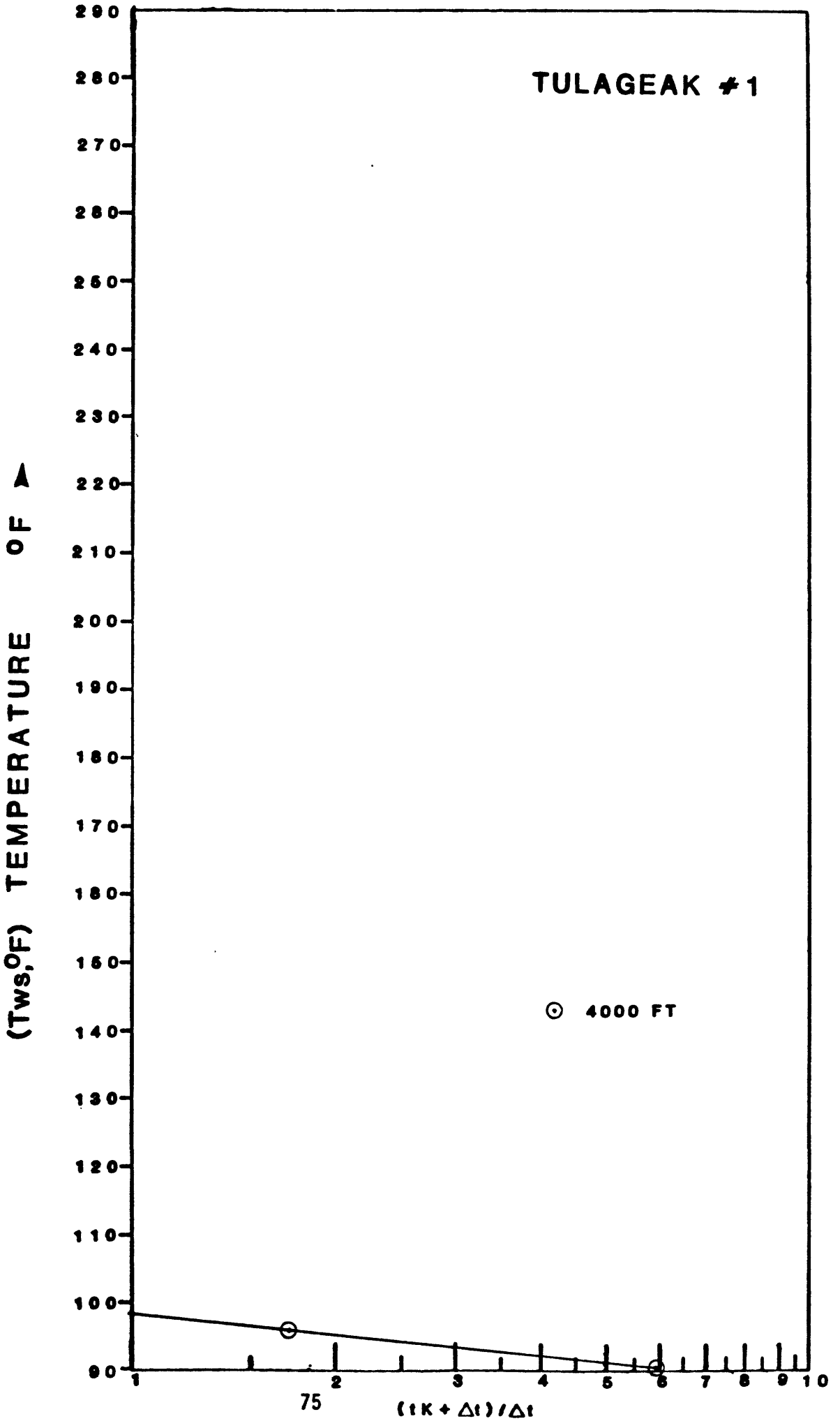

SEABEE #1
6470 FT
9930 FT
12730 FT
(Tws,°F) TEMPERATURE °F
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt

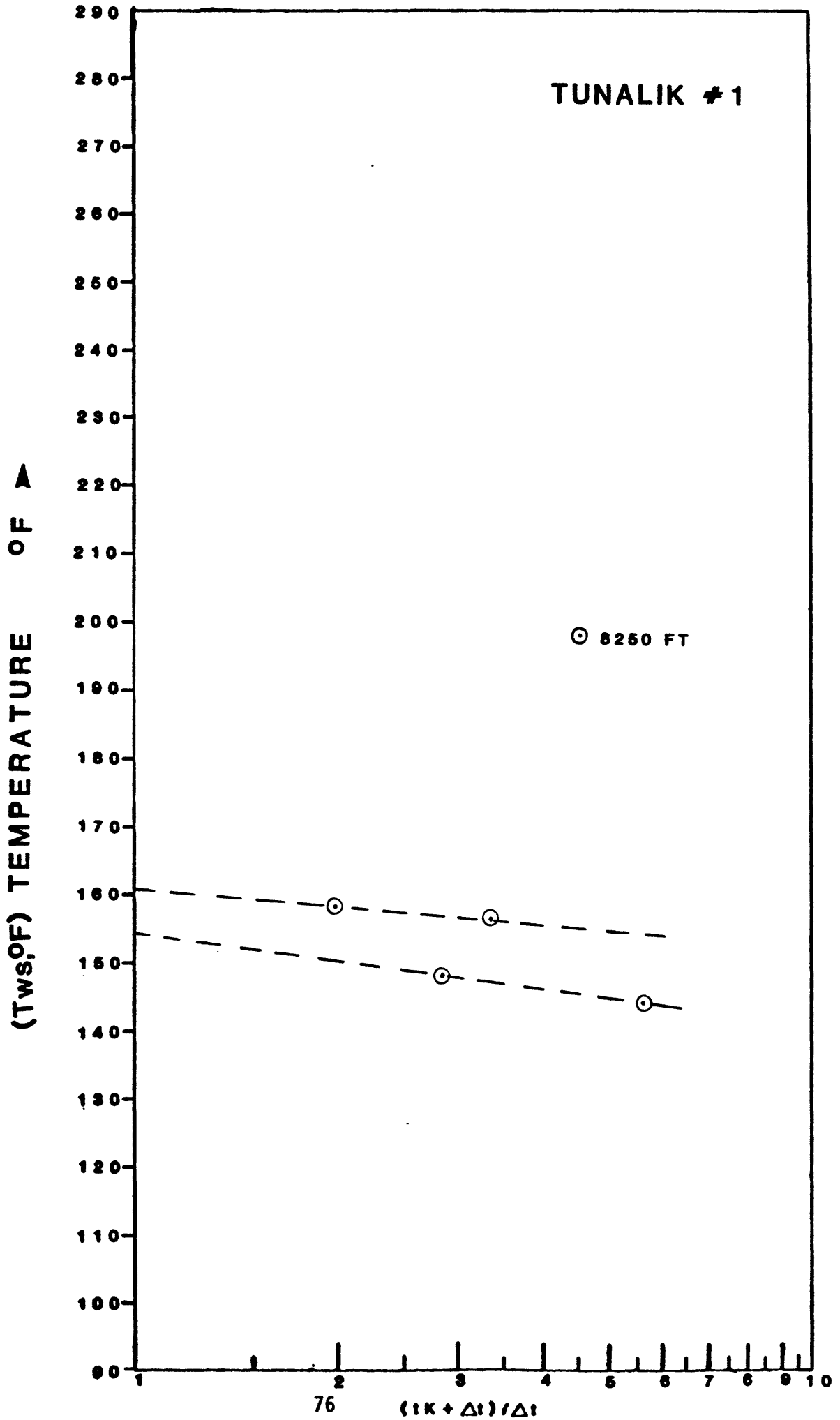

EAST SIMPSON #1
7130 FT
7700 FT
7740 FT
(Tws,°F) TEMPERATURE OF A
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt


EAST SIMPSON #2
6380 FT
7140 FT
7460 FT
(Tws,°F) TEMPERATURE OF ▲
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt) / Δt

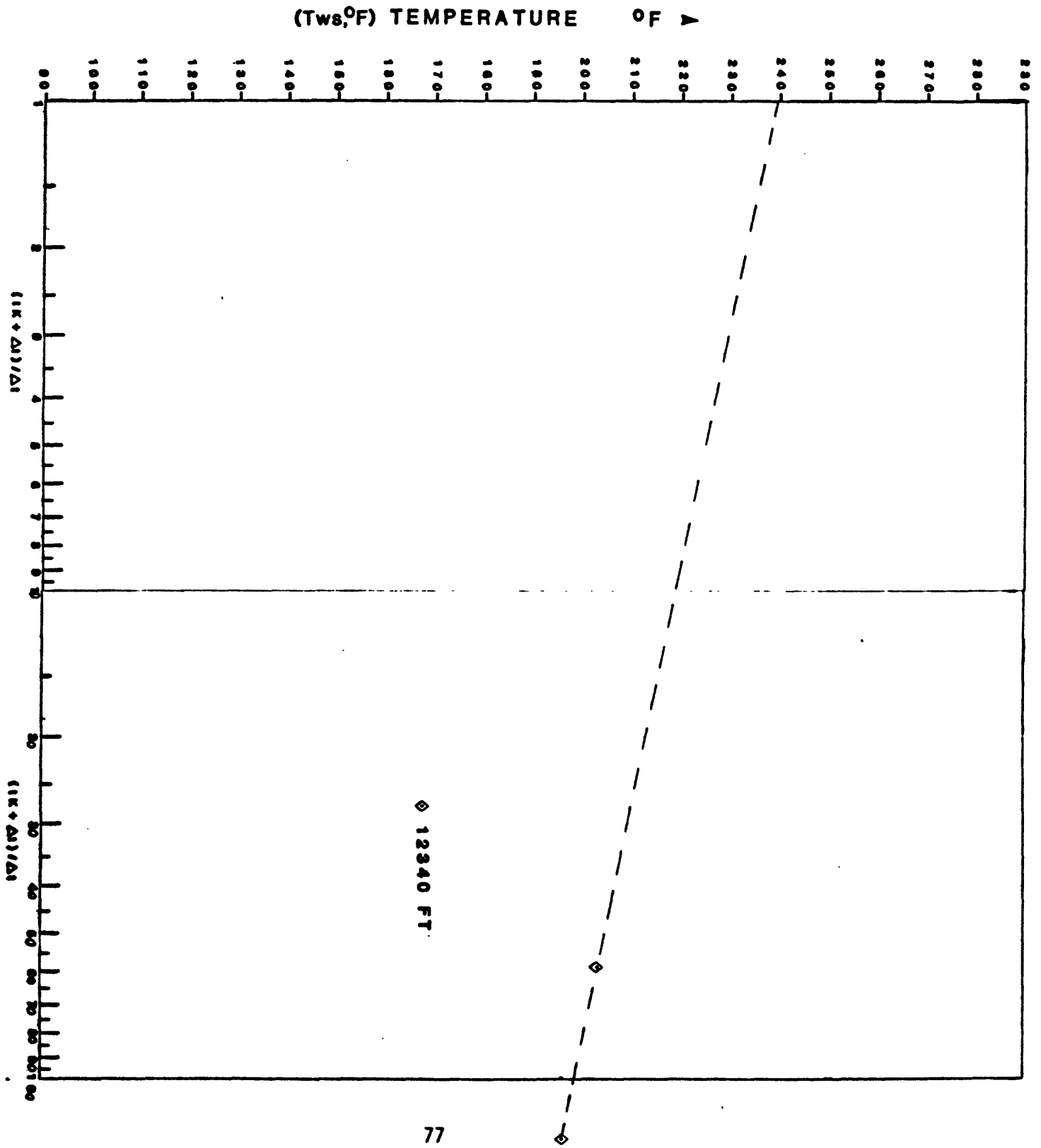

SOUTH SIMPSON #1
7150 FT
8750 FT
(Tws,°F) TEMPERATURE °F
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt) / Δt


EAST TESHEKPUK #1
(Tws,°F) TEMPERATURE OF
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt) / Δt
9280 FT
10610 FT

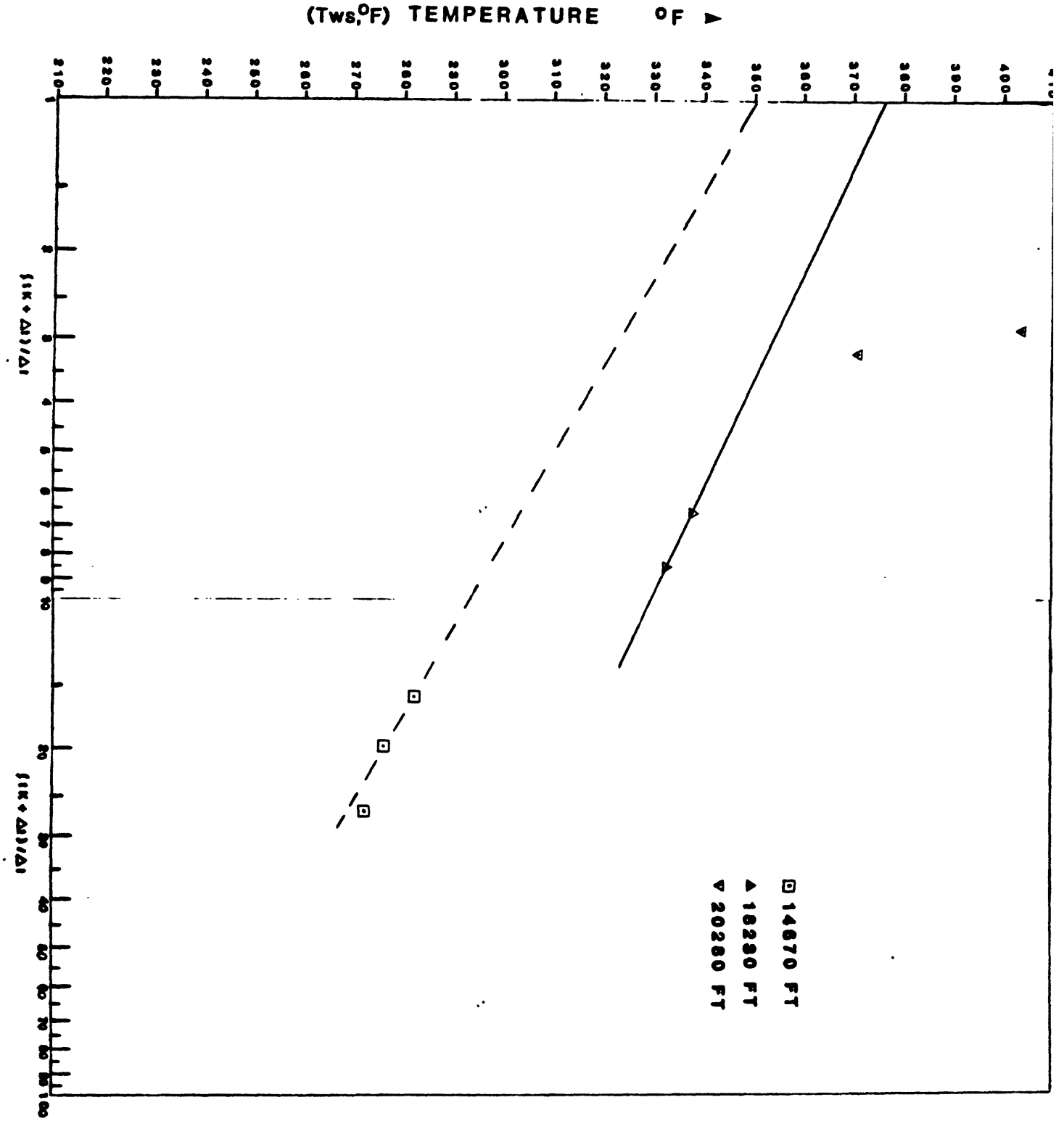

TULAGEAK #1
(Tws,°F) TEMPERATURE OF
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
4000 FT
1
2
3
4
5
6
7
8
9
10
(tK + Δt) / Δt

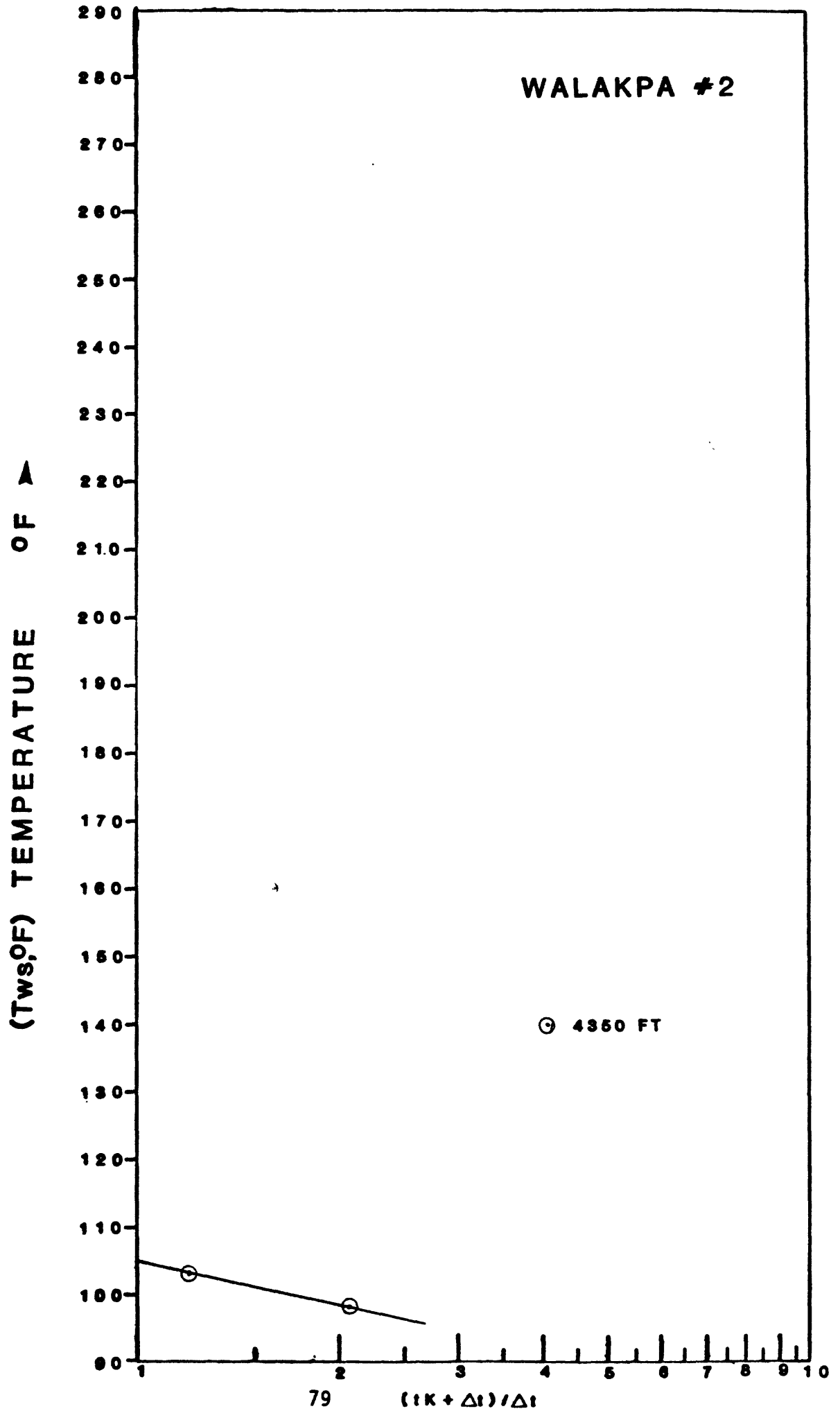

TUNALIK #1
⊙ 8250 FT
(Tws,°F) TEMPERATURE OF ▲
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt

TUNALIK #1


(Tws,°F) TEMPERATURE °F ►
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
(1K + ΔN)/Δt
0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
12340 FT

TUNALIK #1


(Tws,°F) TEMPERATURE °F ►
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
(ΔK + ΔS)/ΔI
0
10
20
30
40
50
60
70
80
90
100
14670 FT
18280 FT
20280 FT


WALAKPA #2
(Tws,°F) TEMPERATURE OF A
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
⊙ 4350 FT
1
2
3
4
5
6
7
8
9
10
(tK + Δt)/Δt