9. OCEANOGRAPHIC OBSERVATIONS IN THE EASTERN INDIAN OCEAN[1]

J. R. Heirtzler, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Ocean currents, either directly through sediment transport, or indirectly through variations in biological activity in the water, affect the distribution of sediments. Since relatively little is known of ocean currents off western Australia, certain observations relevant to ocean currents were made from *Glomar Challenger*. These included: (a) surface temperature and salinity measurements from the bow, on a 4-hour basis when the suspended-sediment water sample was taken, and (b) XBT[2] readings taken from the stern on an approximate 4-hour basis. Bucket-water temperature was taken from the stern at that time as well, to check the calibration of the XBT. Bow readings were usually taken simultaneously with stern readings.

OCEAN SURFACE CURRENTS

While drilling, *Glomar Challenger* should offer an excellent midocean platform for direct observation of ocean currents. However, the instruments to make those observations were not available.

The literature contains little information about currents in this area. Pilot charts for the Indian Ocean (Atlas of Pilot Charts, U.S. Navy, 1966) show that the surface currents off western Australia are controlled by two major current systems:

1) The circum-Antarctic flow south of Australia going from west to east at all times of year, and

2) the currents of the Timor Sea, especially along its northern side, adjacent to Indonesia. These flow into the Indian Ocean, to the west, for all months except March, when flow is to the east.

The currents off western Australia are the result of a shear between these two oppositely directed systems. Since the intensity and geometry, if not direction, of these two systems changes from month to month, the currents in the shear zone change as well.

Off the Australian coast, at least as far west as 110°E the predominant direction of the current is to the south. In January and October, however, the flow direction is to the north. Also, in September and November the southern half of the coast experiences currents to the south, and the northern coast currents to the north. Thus, during the time of Leg 27, the currents were essentially to the south along the coast during the entire time and were to the east between Sites 260 and 262, providing that the Pilot Charts are accurate. Velocities are indicated as being between 13 and 30 km/day (7 and 16 n.m./day). These expected currents do not obviously contradict any experiences on the cruise.

SURFACE SALINITY AND TEMPERATURE

Figure 1 shows observed surface salinity. Values of salinity greater than 35 °/₀₀ are confined to the region south of 26°S and east of 111°E. Values equal to or exceeding 36 °/₀₀ are confined to an even smaller area within about 185 km (100 n.m.) of Site 259. The Oceanographic Atlas of the Indian Ocean (Wyrtki, 1971) shows 35 °/₀₀ values existing south of about 29°S and no 36 °/₀₀ values existing in the area. Thus, the observed values do not agree with those reported by Wyrtki (1971).

Temperatures observed at the surface are shown in Figure 2. The isotherms essentially follow those shown by Wyrtki (1971) with the warm water in excess of 30°C in the Timor Sea being somewhat unexpected. A T-S diagram of the surface waters reinforces this tendency of higher temperatures to be associated with lower salinities and lower temperatures to be associated with higher salinities to the south. The T-S diagram does not allow identification of separate water masses in the area.

TEMPERATURE STRUCTURE OF THE UPPER 200 METERS

Seventy-eight XBT measurements were taken at the positions indicated in Figure 3. The actual XBT records are shown in Figures 4 and 5 and the times and surface readings are given in Table 1.

The XBT records show a thermocline, usually at about 30 meters (100 ft) in depth. The records also show many small-scale temperature fluctuations with many similar fluctuations persisting onto the next record—a distance of about 90 km (50 n.m.). These are probably caused by a localized turbulence phenomenon.

From the individual XBT records it is possible to construct two north-south temperature-depth profiles, one for the northbound leg and one for the southbound legs (Figures 6 and 7). The chief characteristic of the profiles is a rising towards the surface of the isotherms as one proceeds south from about 15°S. The isotherms are at a more constant level in the area north of about 15°S, confirming the general observations of Wyrtki (1971). The simplest explanation of these facts is a gentle mixing of water down to 200 meters by flow from the Timor Sea, but less homogenized water off western Australia.

ACKNOWLEDGMENTS

The U.S. Naval Postgraduate School, Monterey, California, supplied the XBT's, and M. Fields took the XBT readings. H. Hays plotted temperature profiles and assisted with other graphic work. Their efforts are appreciated.

[1]Woods Hole Oceanographic Institution Contribution No. 3199.

[2]XBT = expendable bathythermograph.

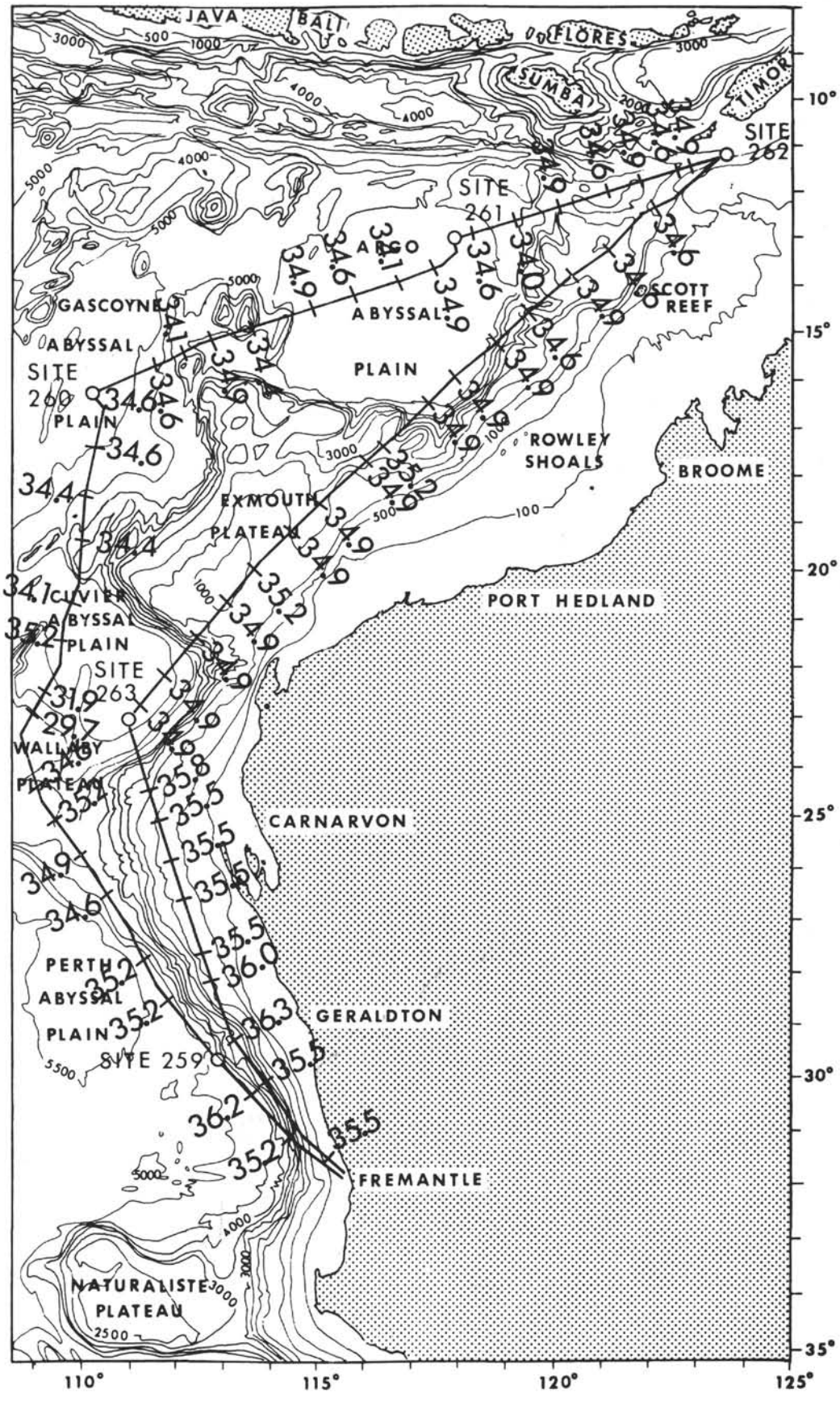

Figure 1. *Observed surface salinity,* $^{\circ}/_{\circ\circ}$.

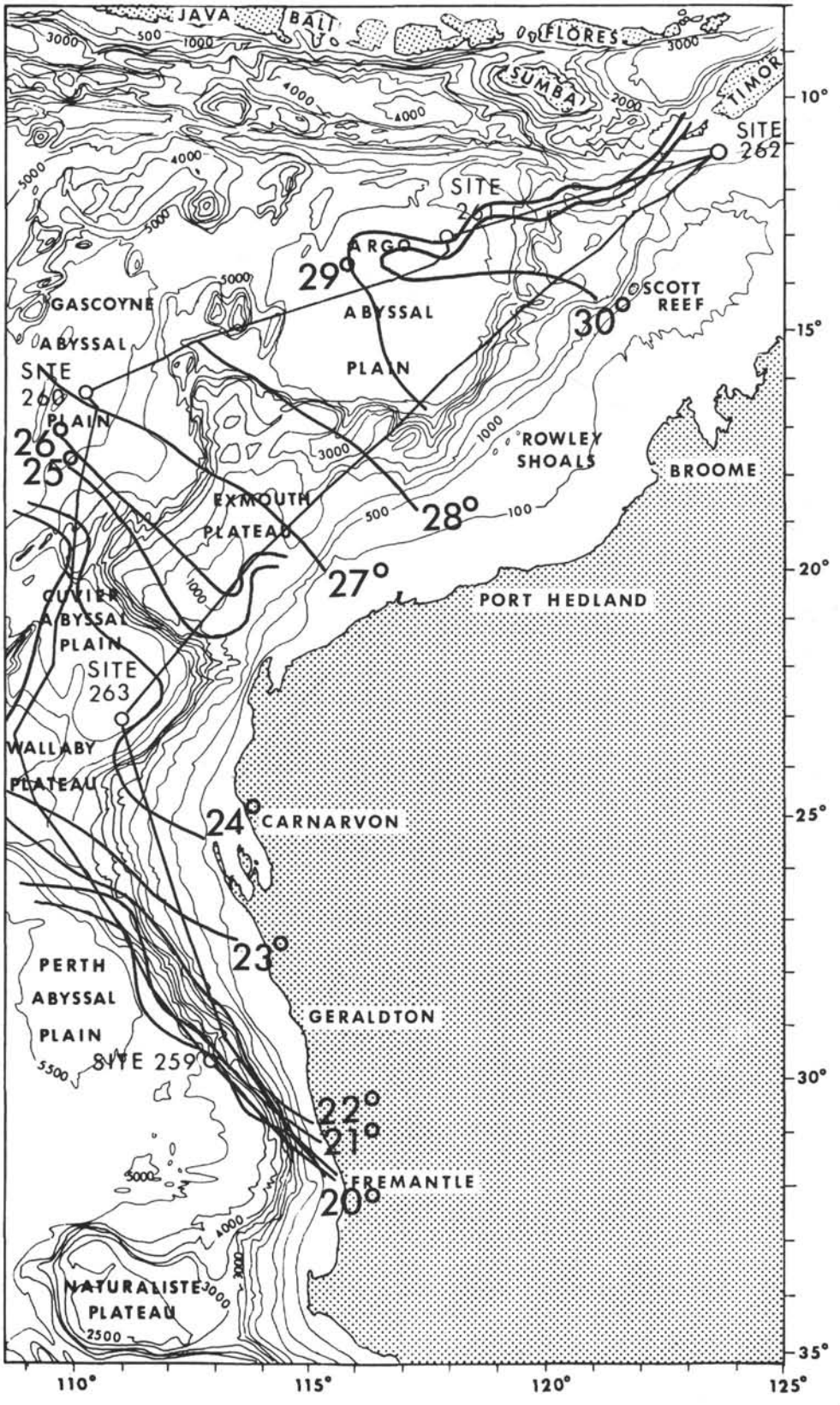

Figure 2. *Observed surface temperature, °C.*

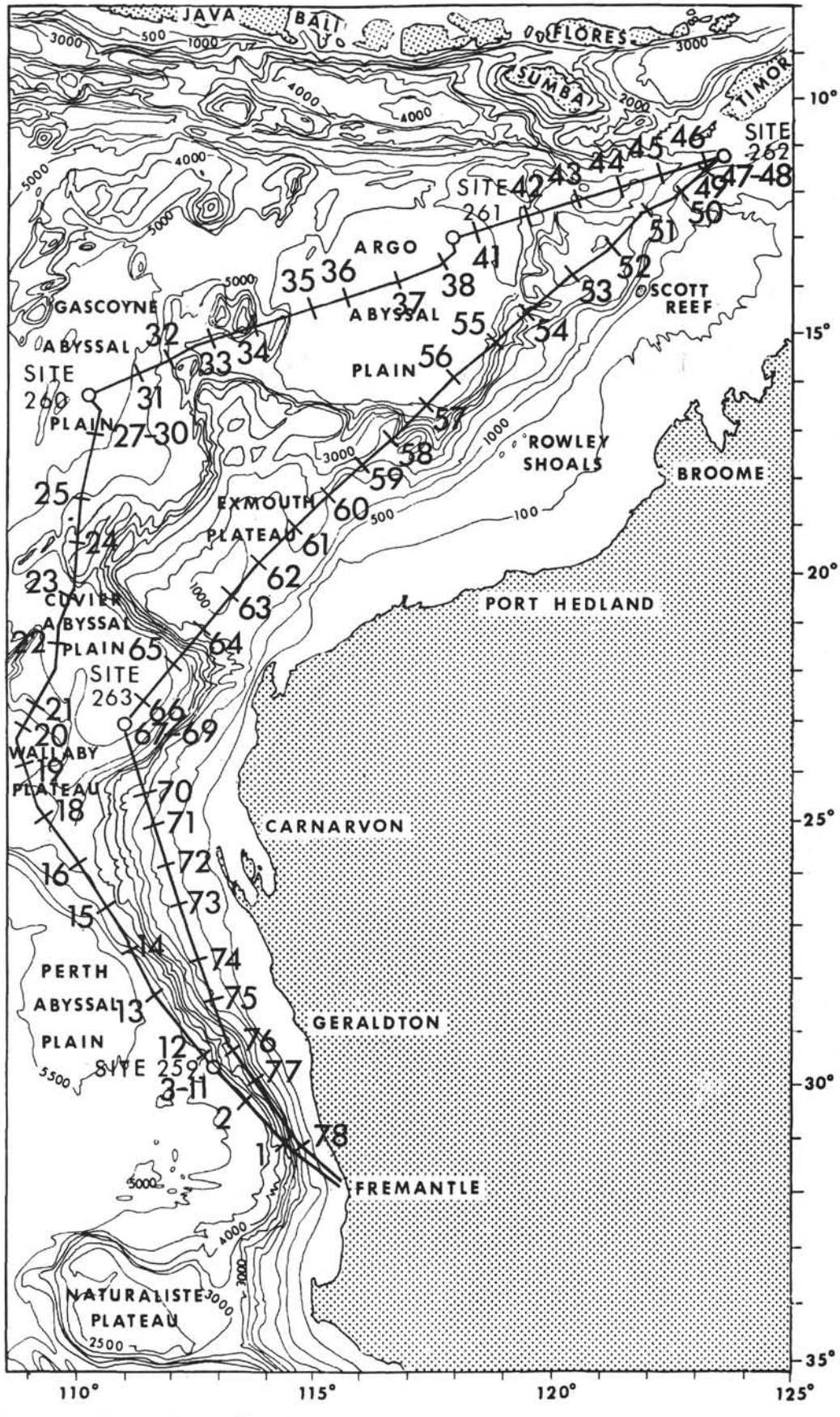

Figure 3. *XBT number and locations.*

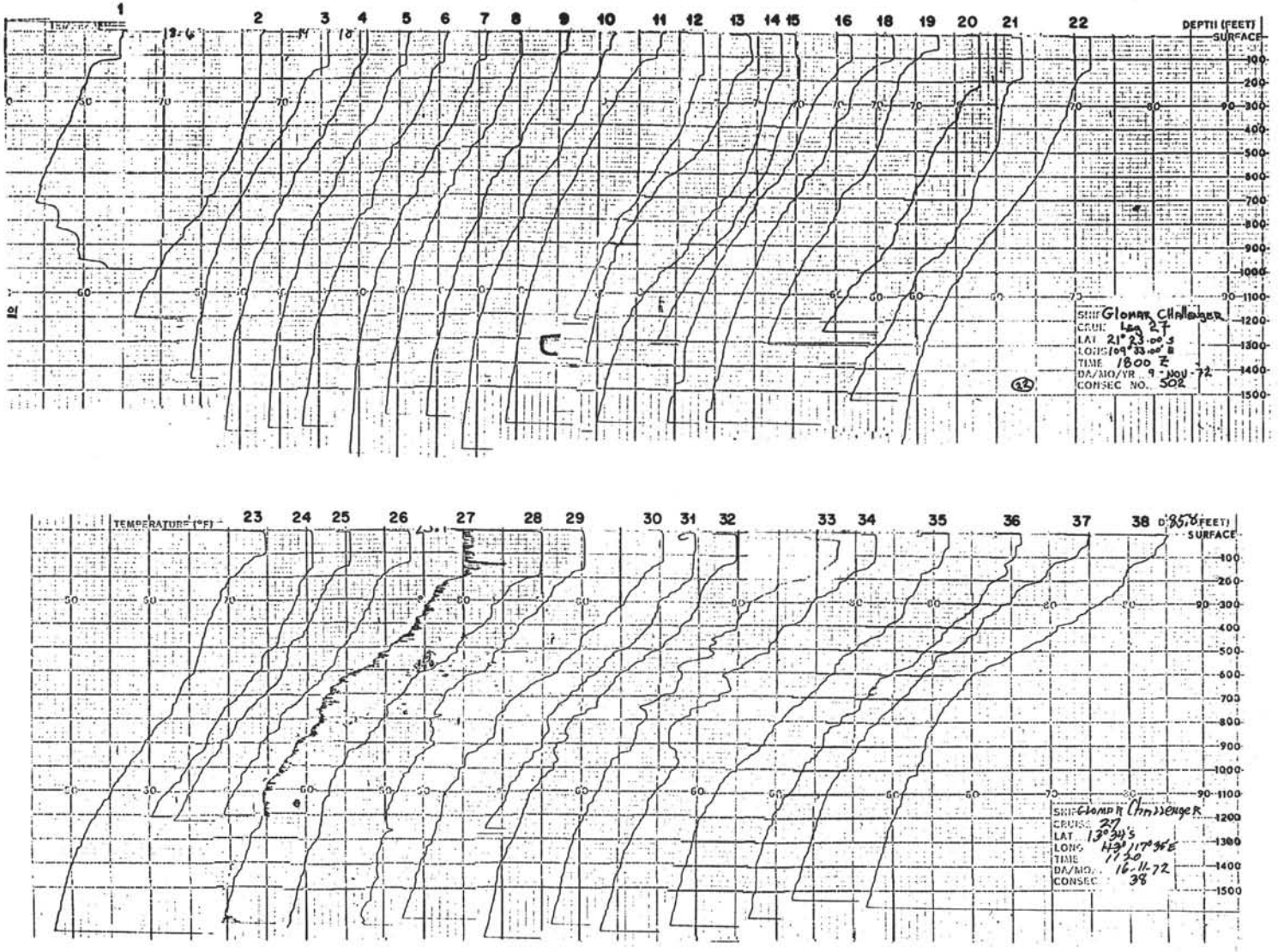

Figure 4. *XBT records, depth scale in feet and temperature scale in °F. Surface temperature is given in Table 1.*

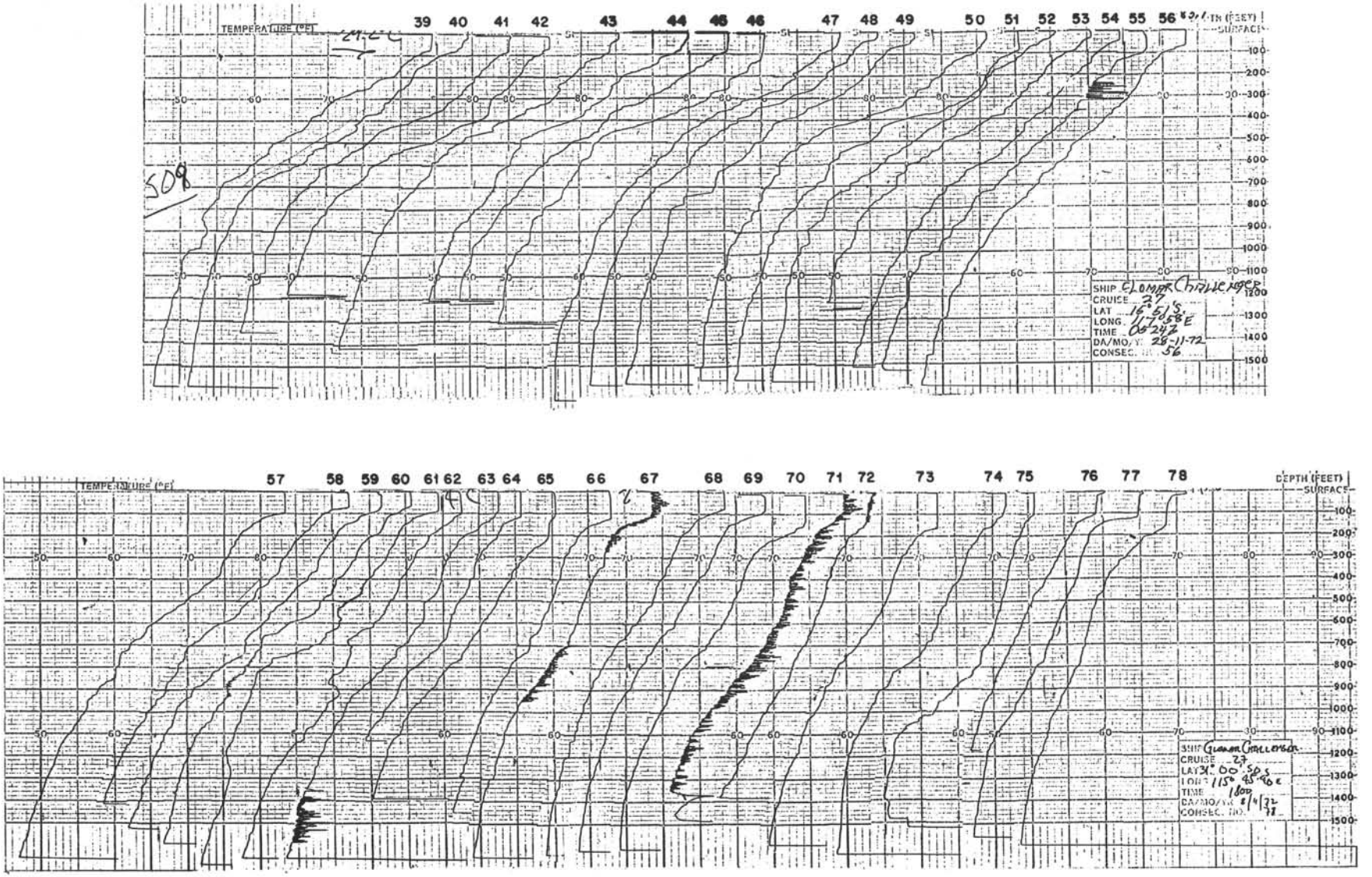

Figure 5. *XBT records, depth scale in feet and temperature scale in °F. Surface temperature is given in Table 1.*

TABLE 1
XBT Measurements – Leg 27, *Glomar Challenger*
2 November-9 December 1972

XBT No.	Date	Time (Z)	Stern Surface Temp. (°F)	Latitude	Longitude	Filter No.
1	2 Nov.	0400	65.5	31°12'S	114°30'E	2101
2	2 Nov.	1015	68.0	30°24'S	113°41'E	2102
3	2 Nov.	1600	66.0	29°47'S	112°46'E	2103
4	2 Nov.	2200	66.2	29°42'S	112°42'E	2104
5	3 Nov.	0000	66.7	29°37'S	112°41'E	2105
6	3 Nov.	1000	65.8	29°37'S	112°42'E	2106
7	4 Nov.	0005	66.5	29°37'S	112°42'E	2107
8	4 Nov.	2200	64.9	29°37'S	112°42'E	2108
9	5 Nov.	0320	66.2	29°37'S	112°42'E	2109
10	5 Nov.	0930	67.3	29°37'S	112°42'E	2110
11	7 Nov.	0520	68.0	29°37'S	112°42'E	2120
12	7 Nov.	1120	68.0	29°37'S	112°30'E	
13	7 Nov.	1800	68.5	29°36'S	111°41'E	2124
14	7 Nov.	2310	68.0	27°25'S	111°03'E	
15	8 Nov.	0510	69.8	26°38'S	110°33'E	
16	8 Nov.	1110	71.6	25°47'S	110°04'E	
17						
18	8 Nov.	1800	72.5	24°46'S	109°23'E	2118
19	8 Nov.	2320	72.9	24°00'S	108°53'E	
20	9 Nov.	0530	72.9	23°09'S	108°32'E	501
21	9 Nov.	1115	73.4	22°22'S	109°07'E	
22	9 Nov.	1800	72.1	21°23'S	109°33'E	502
23	9 Nov.	2320	74.8	20°30'S	109°45'E	
24	10 Nov.	0535	76.3			
25	10 Nov.	1120	75.6	18°25'S	110°10'E	
26	10 Nov.	1815	78.3	17°04'S	110°15'E	504
27	10 Nov.	2315	80.1	16°14'S	110°28'E	
28	11 Nov.	1125	80.2	16°09'S	110°18'E	2130
29	13 Nov.	1210	80.3	16°09'S	110°18'E	
30	14 Nov.	1205	80.2	16°09'S	110°18'E	
31	14 Nov.	1915	79.5	15°45'S	111°10'E	
32	14 Nov.	2325	80.1	15°31'S	111°39'E	2148
33	15 Nov.	0517	82.9	15°10'S	112°42'E	506
34	15 Nov.	1125	82.6	14°51'S	113°41'E	2149
35	15 Nov.	1820	81.9	14°31'S	114°44'E	507
36	15 Nov.	2328	81.7	14°12'S	115°42'E	2150
37	16 Nov.	0518	85.8	13°52'S	116°37'E	508
38	16 Nov.	1120	85.8	13°34'S	117°35'E	2151
39	16 Nov.	1800	84.6	12°56'S	117°51'E	509
40	22 Nov.	0001	84.4	12°56'S	117°51'E	2152
41	22 Nov.	0525	85.8	12°46'S	118°34'E	510
42	22 Nov.	1110	86.0	12°28'S	119°26'E	2173
43	22 Nov.	1800	85.5	12°03'S	120°30'E	511
44	22 Nov.	2320	84.6	11°49'S	121°19'E	
45	23 Nov.	0520	85.8	11°34'S	122°19'E	512
46	23 Nov.	1115	86.2	11°15'S	123°13'E	2175
47	23 Nov.	1800	86.2	10°51'S	123°53'E	513
48	25 Nov.	2330	86.4	10°51'S	123°53'E	2184
49	26 Nov.	1115	86.7	11°16'S	123°25'E	2185
50	26 Nov.	1800	86.7	12°06'S	122°29'E	515
51	26 Nov.	2325	85.4	12°41'S	121°45'E	
52	27 Nov.	0522	85.6	13°20'S	120°59'E	516
53	27 Nov.	1120	85.5	13°52'S	120°14'E	2187
54	27 Nov.	1800	84.2	14°32'S	119°20'E	517
55	27 Nov.	2320	83.3	15°09'S	118°45'E	2188
56	28 Nov.	0524	83.7	15°51'S	117°58'E	518
57	28 Nov.	1115	83.3	16°25'S	117°19'E	2189
58	28 Nov.	1800	82.1	17°26'S	116°24'E	519
59	28 Nov.	2320	81.3	17°45'S	115°57'E	2190
60	29 Nov.	0533	81.0	18°21'S	115°13'E	520

TABLE 1 – *Continued*

XBT No.	Date	Time (Z)	Stern Surface Temp.(°F)	Latitude	Longitude	Filter No.
61	29 Nov.	1115	79.7	18°55'S	114°35'E	2191
62	29 Nov.	1800	77.7	19°48'S	113°47'E	521
63	29 Nov.	2318	77.9	20°26'S	113°14'E	
64	30 Nov.	0519	76.7	21°10'S	112°37'E	522
65	30 Nov.	1120	75.6	21°54'S	111°56'E	
66	30 Nov.	1800	73.4	22°42'S	111°17'E	523
67	30 Nov.	2305	73.4	23°12'S	110°51'E	
68	3 Dec.	2330	73.4	23°19'S	110°57'E	2205
69	6 Dec.	0620	74.5	23°19'S	110°57'E	
70	6 Dec.	1800	75.2	24°25'S	111°24'E	524
71	6 Dec.	2320	74.8	25°04'S	111°37'E	
72	7 Dec.	0520	73.8	25°49'S	111°56'E	525
73	7 Dec.	1120	73.4	26°37'S	112°15'E	
74	7 Dec.	1800	72.0	27°45'S	112°43'E	526
75	7 Dec.	2330	71.2	28°26'S	112°56'E	
76	8 Dec.	0540	70.3	29°23'S	113°27'E	
77	8 Dec.	1120	71.6	30°05'S	114°02'E	2218
78	8 Dec.	1800	71.2	31°00'S	115°45'E	528

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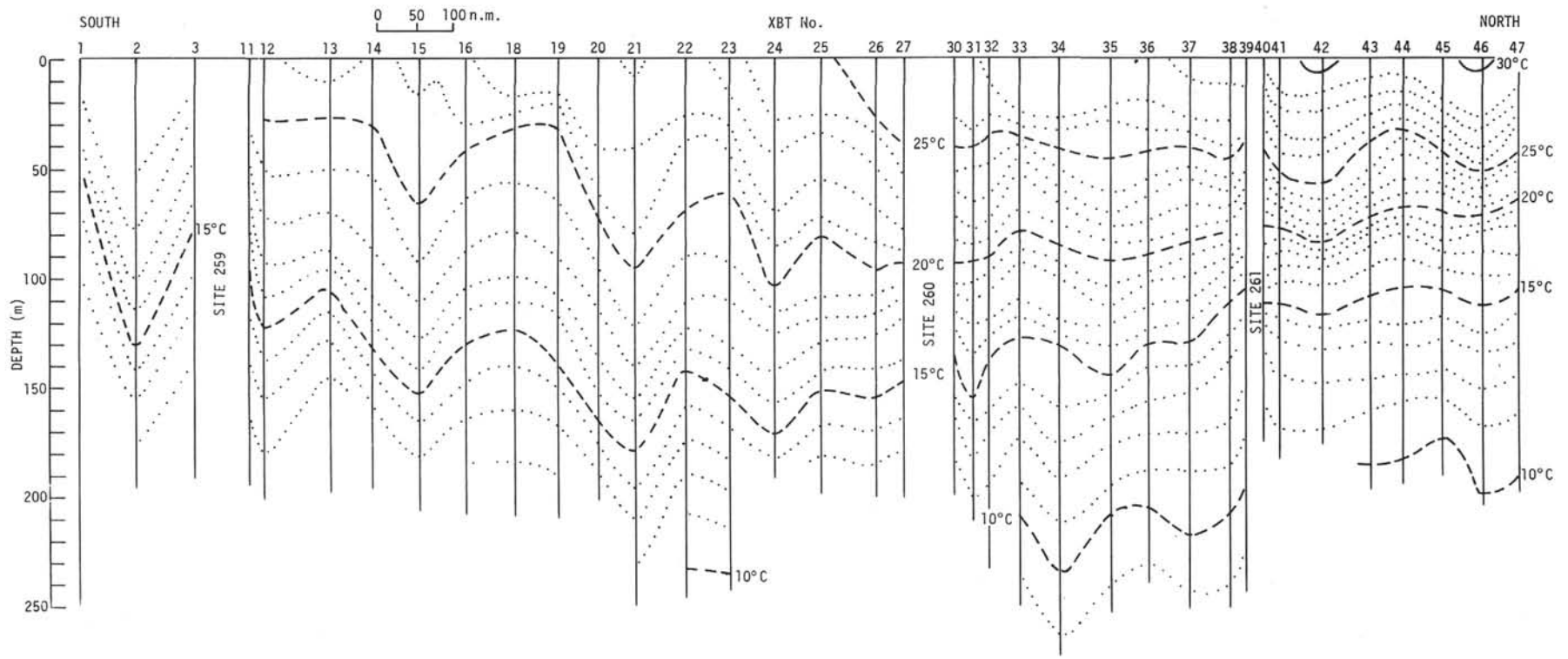

Figure 6. *Temperature depth profile for the northerly track, depth in meters and temperature in °C.*

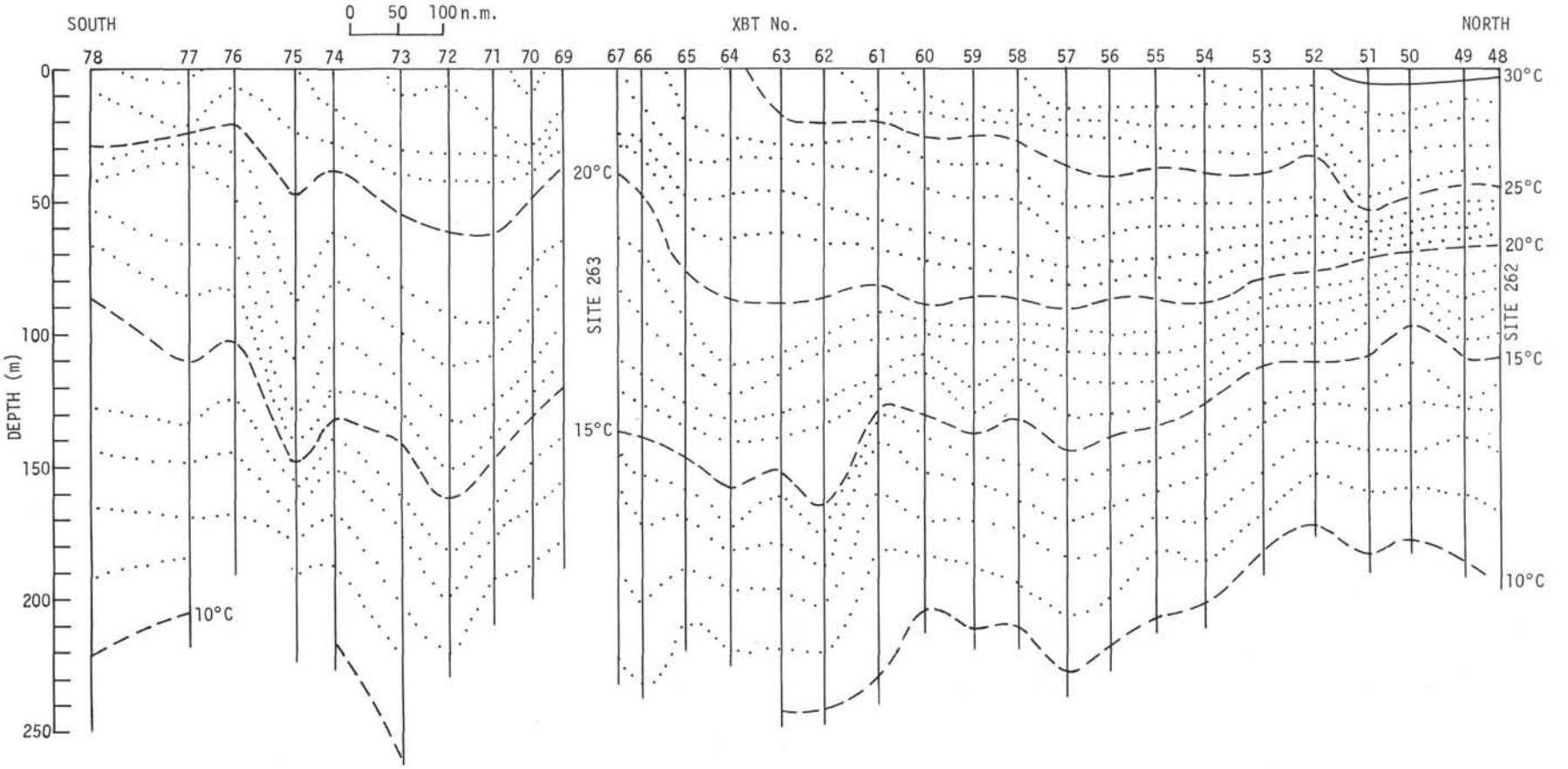

Figure 7. *Temperature depth profile for the southerly track, depth in meters and temperature in °C.*