NOAA Technical Report NMFS SSRF-719

Seasonal Description of Winds and Surface and Bottom Salinities and Temperatures in the Northern Gulf of Mexico, October 1972 to January 1976

Perry A. Thompson, Jr. and Thomas D. Leming

February 1978

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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Seasonal Description of Winds and Surface and Bottom Salinities and Temperatures in the Northern Gulf of Mexico, October 1972 to January 1976[1]

PERRY A. THOMPSON, JR.[2] and THOMAS D. LEMING[3]

ABSTRACT

Seasonal surface and bottom salinities and temperatures in the northern Gulf of Mexico are described. The area surveyed, from October 1972 to January 1976, was between Mobile Bay, Ala. (long. 88°00'W), and Atchafalaya Bay, La. (long. 91°30'W), from 5 to 50 fathoms (9 to 91 m).

INTRODUCTION

Published hydrographic data from the Gulf of Mexico generally deal with the central gulf rather than the continental shelf. Rivas (1968), Drennan (1968), and Wiseman et al. (1976) studied surface temperature in the central gulf, subsurface circulation over the shelf, and effects of the Mississippi River discharge on temperature and salinity of the inner shelf west of the Mississippi River. Many studies have been completed on temperature and salinity observations and seasonal trends on the shelf of the northern Gulf of Mexico. The most recent study for the northwestern Gulf of Mexico is that of Temple et al. (1977) and for the northeastern that of Christmas et al.[4]

Because the northern shelf of the Gulf of Mexico is the richest fish producing area in the gulf, considerable effort should be directed toward understanding the hydrography and its effects on the environment of marine life. In 1972 the National Marine Fisheries Service started a program to evaluate the industrial and foodfish demersal fishery in the northern Gulf of Mexico and to provide associated environmental information for the area. Environmental variables recorded during groundfish cruises were temperature, salinity, and bottom type. These variables can be correlated with densities of finfish later to determine their influence on abundance and distribution of the finfish stocks.

In this paper we give a brief description of surface and bottom temperatures and salinities and establish their general seasonal variability in the northern gulf. Temperature appears to be an important factor in the movement of juvenile groundfish from the estuaries (Franks et al. 1972). Determination of seasonality would be beneficial in understanding this aspect of the life history of groundfish in the northern Gulf of Mexico.

SURVEY AREA

Initially the primary fishing grounds encompassed the area from 5 to 50 fathoms (9 to 91 m) between Perdido Bay, Fla. (long. 87°30'W), and Ship Shoal, La. (long. 91°30'W) (Roithmayr 1965). This area was later reduced to between Mobile Bay, Ala. (long. 88°00'W), and Ship Shoal, La. (long. 91°30'W), because of the low density of groundfish east of Mobile Bay (Gutherz et al. 1975). The primary area was divided into three survey segments (Fig. 1): 1) east of the Delta, SA1 (long. 88°00' to 89°00'W); 2) off the Delta, SA2 (long. 89°00' to 90°00'W); and 3) west of the Delta, SA3 (long. 90°00' to 91°30'W).

METHODS AND PROCEDURES

For each cruise, 35 to 45 hydrographic stations were selected both east and west of the mouth of the Mississippi River. These stations were preselected from fishing stations along transect lines at 20' longitude intervals. If no fishing stations were located along a transect line, then the closest fishing stations to the transect were selected. Hydrographic stations were separated by 10 to 15 km along the transect line. Because of the random selection of fishing stations, the probability of repeating the same hydrographic station for each cruise was low. Stations were located by loran-A or radar.

Equipment used to acquire data on the various cruises is listed in Table 1. All equipment was calibrated at the beginning of each cruise. Temperatures were measured with an expendable bathythermograph (XBT) and recorded to the nearest 0.1°C on cruises 40 to 52. Salinity data were not taken during cruises 40 to 48. On cruise 52 surface and bottom salinities were recorded to the nearest part per thousand (ppt) using a Goldbert T/C refractometer. On cruises 55 to 64, salinity and tem-

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[3]Southeast Fisheries Center National Fisheries Engineering Laboratory, National Marine Fisheries Service, NOAA, NSTL, Bay St. Louis, MS 39520.

[4]Christmas, J. Y., A. Perry, and R. S. Waller. 1974. Investigations of coastal pelagic fishes completion report. Gulf Coast Research Laboratory, Ocean Springs, Miss., 90 p.

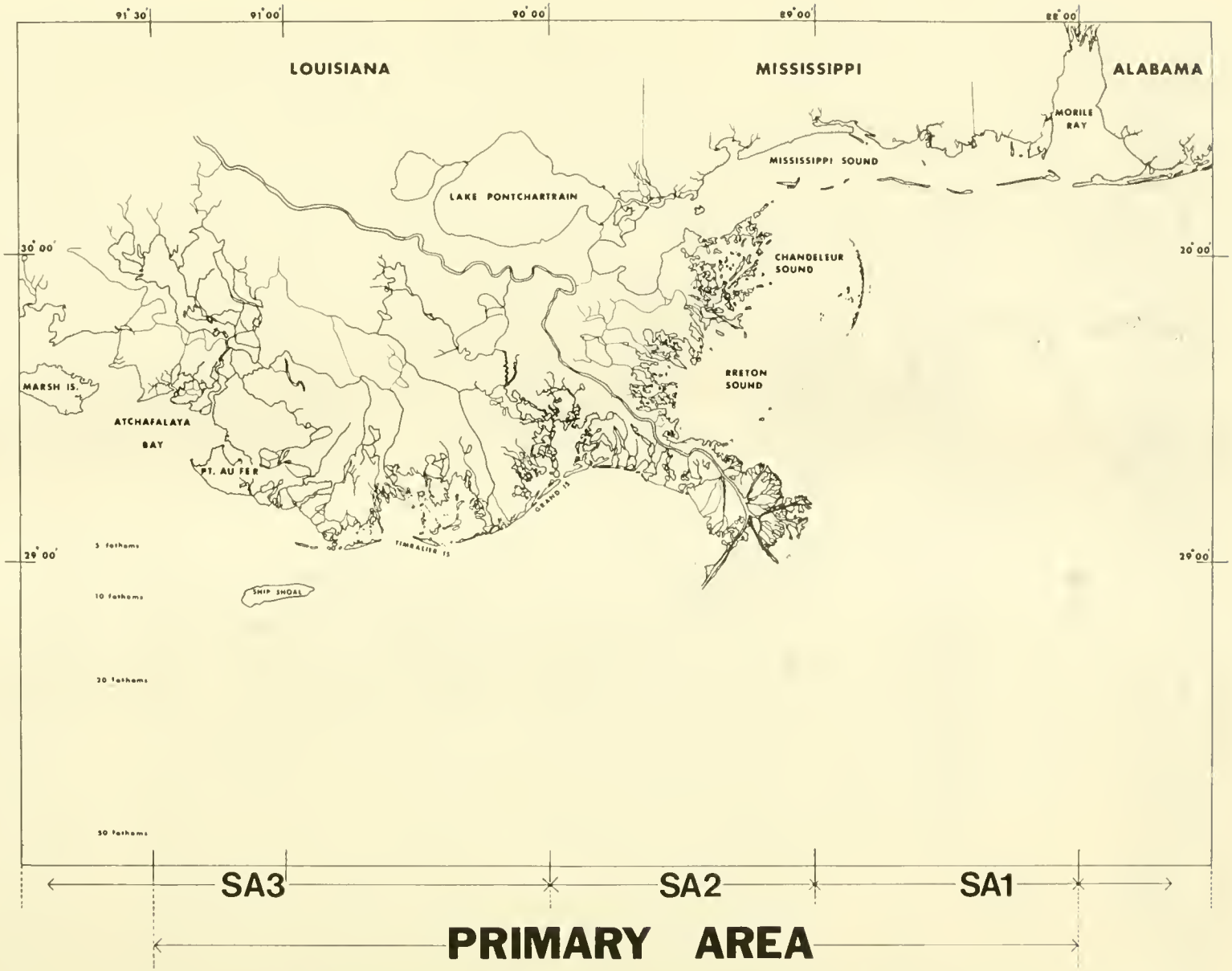

Figure 1.—Primary fishing area for the industrial bottomfish fishery in the northern Gulf of Mexico.

Table 1.—Data and hydrographic equipment used on the FRS *Oregon II* groundfish cruises.

Cruise no.	Date	Hydrographic equipment				Salinity		Temperature	
		XBT	STD	Niskin bottles	Refractometer	Surface	Bottom	Surface	Bottom
40	Oct. 1972	X						X	X
42	Nov. 1972	X						X	X
44	Apr. 1973	X						X	X
48	Nov. 1973	X						X	X
51	June 1974	X			X			X	X
52	Aug. 1974	X		X	X	X	X	X	X
55	Nov. 1974		X		X	X	X	X	X
57	Mar. 1975		X		X	X	X	X	X
60	July 1975		X		X	X	X	X	X
62	Nov. 1975		X		X	X	X	X	X
64	Jan. 1976		X		X	X	X	X	X

perature were recorded using a Plessey Environmental System Model No. 9060 Graphic, self-recorded, STD unit. The degree of variation between the STD and the refractometer was 0.5 ppt. Because the XBT failed on cruise 44 and the STD on cruise 55, the environmental data are incomplete east of the Delta. Weather data were taken from the FRS *Oregon II* weather log for cruises 48 to 64. The September and October wind roses for SA2 and SA3 are incomplete because of inadequate weather data for that time.

Figures 2 to 43 show mean bimonthly differences between surface and bottom temperature and salinity, mean bimonthly air temperature, and surface and bottom isotherms and isohalines for each cruise. Isotherm contours were not drawn for cruise 40 (Fig. 9) because of the narrow range between data points. Isotherms and isohaline contours were not drawn around the mouth of the Mississippi River (Figs. 9 to 37, 39, 42) because of the wide range in values due to the influence of the Mississippi River.

Table 2.—Mean bimonthly surface and bottom temperatures (°C) for each survey area. The top figure represents surface temperature and the bottom figure represents the bottom temperature.

Survey area	Jan.-Feb.	Mar.-Apr.	May-June	July-Aug.	Sept.-Oct.	Nov.-Dec.
			5 to 9 fathoms			
	13.5	17.7	25.7	28.9	28.7	21.9
SA1	14.6	18.1	22.7	25.2	28.3	22.8
	12.7	17.8	29.2	29.5	26.7	22.8
SA2	16.5	19.1	23.7	26.4	27.8	21.6
	12.9	19.6	27.0	29.6	27.7	20.7
SA3	16.4	19.6	26.1	27.1	27.6	21.5
			10 to 19 fathoms			
	15.3	18.1	25.6	27.9	28.7	25.2
SA1	17.4	19.2	21.7	23.9	26.2	22.9
	12.4	18.9	28.0	29.8	22.3	22.2
SA2	19.9	20.6	22.6	24.4	26.3	24.2
	14.3	19.9	25.7	29.4	28.0	22.2
SA3	18.4	20.2	23.8	24.8	27.8	23.2
			20 to 50 fathoms			
	18.6	18.6	27.1	28.7	28.6	23.6
SA1	19.5	20.4	21.7	21.2	22.1	23.7
	11.9	18.1	26.5	29.6	26.4	21.3
SA2	19.6	19.8	19 7	19.3	21.1	24.1
	17.9	20.4	26.9	29.7	28.0	22.1
SA3	19.2	20.3	20.3	20.3	22.6	22.9

DISCUSSION

Meteorological conditions and the discharge from the Mississippi River within this survey area have a significant effect on seasonal variations (Drennan 1968). Within the primary area, salinity and temperature data have been separated by depth and survey area to detect seasonal changes. Calculated bimonthly mean surface and bottom temperatures are shown in Table 2. Mean differences between surface and bottom temperatures have been computed bimonthly to demonstrate an annual seasonal cycle for each survey area (Figs. 2-4). Data indicated that both a summer and winter season are well defined within the primary area. The change in seasons is recognized when surface and bottom temperatures are similar. The summer season begins in March and April at all depths. This change is correlated with changing meteorological conditions as the wind shifts from a northerly to a southerly direction (Figs. 2-4). This shift in direction is accompanied by a decrease in intensity of wind speed and an increase in air temperature (Fig. 5). Water and air temperatures reach a peak in July and August accompanied by frequent calm winds (Figs. 2-4). Little wind-mixing during the period, coupled with solar heating, results in a large difference between surface and bottom temperatures. The summer season begins to disappear in September and October with a drop in air temperature and a wind shift. By November and December the winter season has begun with southeasterly winds shifting to a more northerly direction (Figs. 2-4). This change in wind direction and intensity produces northers, causing the mean air temperature to drop approximately 9°C from the July and August high (Leipper 1954). The wind generally remains out of the north to northwest in January and February bringing colder temperatures within the survey area. This is the coldest period of the year. By March and April the winter season ends with a general warming of air temperature and a wind shift to the southeast, thus completing the annual cycle.

The importance of the Loop Current and its role in the circulation pattern on the shelf has been described by Drennan (1968). Bottom salinities at all depths in the three survey areas are similar and relatively constant because of the influence of the Loop Current (Drennan 1968) (Figs. 6-8). Surface salinities vary within each survey area, indicating seasonal changes that can be attributed to the discharge from the Mississippi River and calm weather during the summer months (Drennan 1968). The Mississippi River flood period peaks in April and May with a 17-yr average of 3,668 m^3/s.[5] These flood periods are reflected in lower surface salinities for SA2 (Fig. 7) and to some extent in SA1 and SA3 for May and June (Figs. 6, 8).

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Our appreciation is extended to the Louisiana State University Department of Marine Science for the use of the Plessey STD unit and the assistance of Gene Turner and Bob Allen. Also, thanks are extended to Elmer J. Gutherz for his guidance, and to Tommy Strowd for drawing the isohalines and isotherms on the charts. Additional thanks are given to the scientific party and crew of the FRS *Oregon II*.

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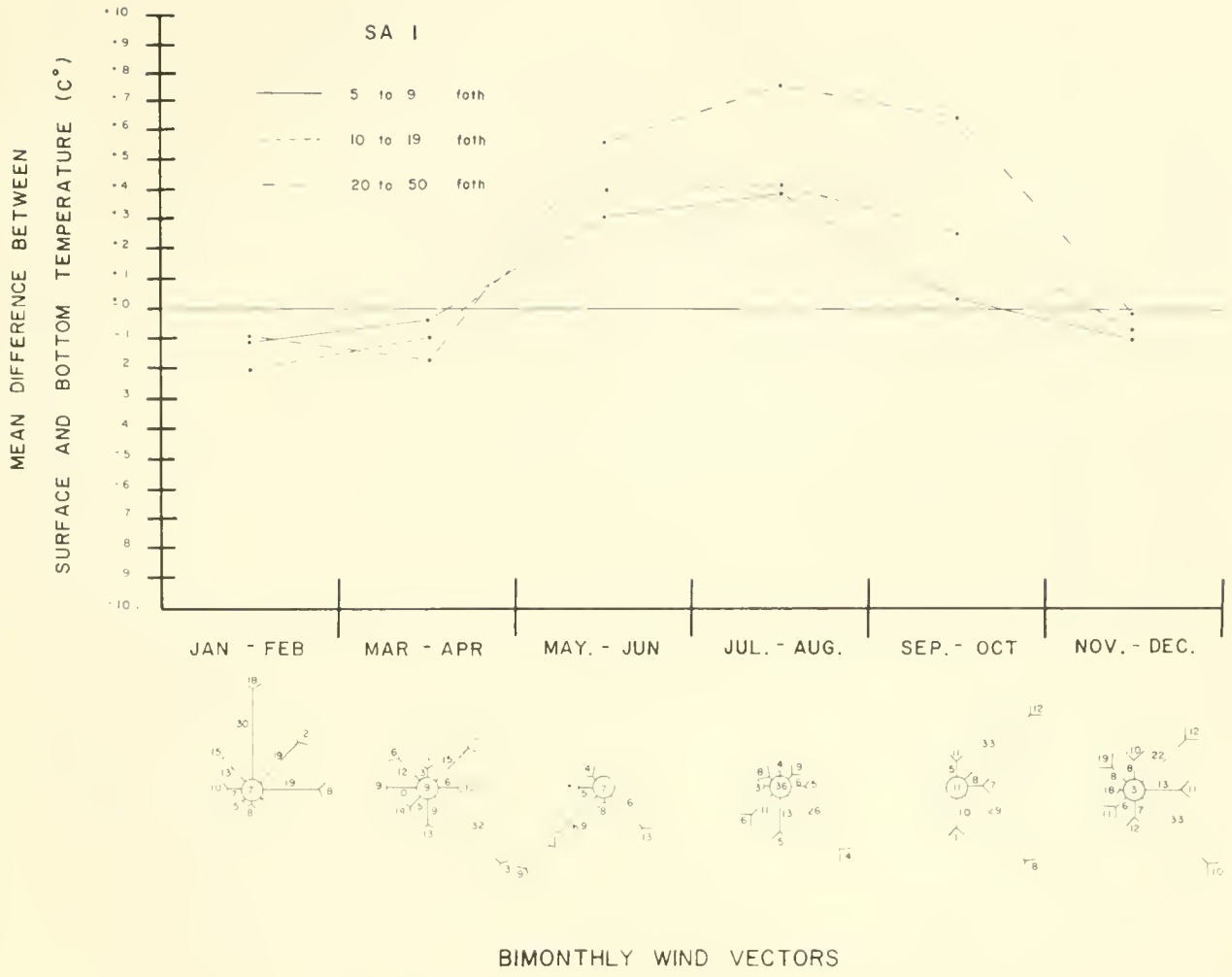

Figure 2.—Bimonthly mean difference between surface and bottom water temperatures and associated wind roses east of the Mississippi River Delta (SA1). Wind roses: Arrows fly with the wind based on eight points of the compass. Each wind rose indicates the average wind speed at the end of the arrow, percent frequency at center of arrow, and percentage of calm or light winds are encircled.

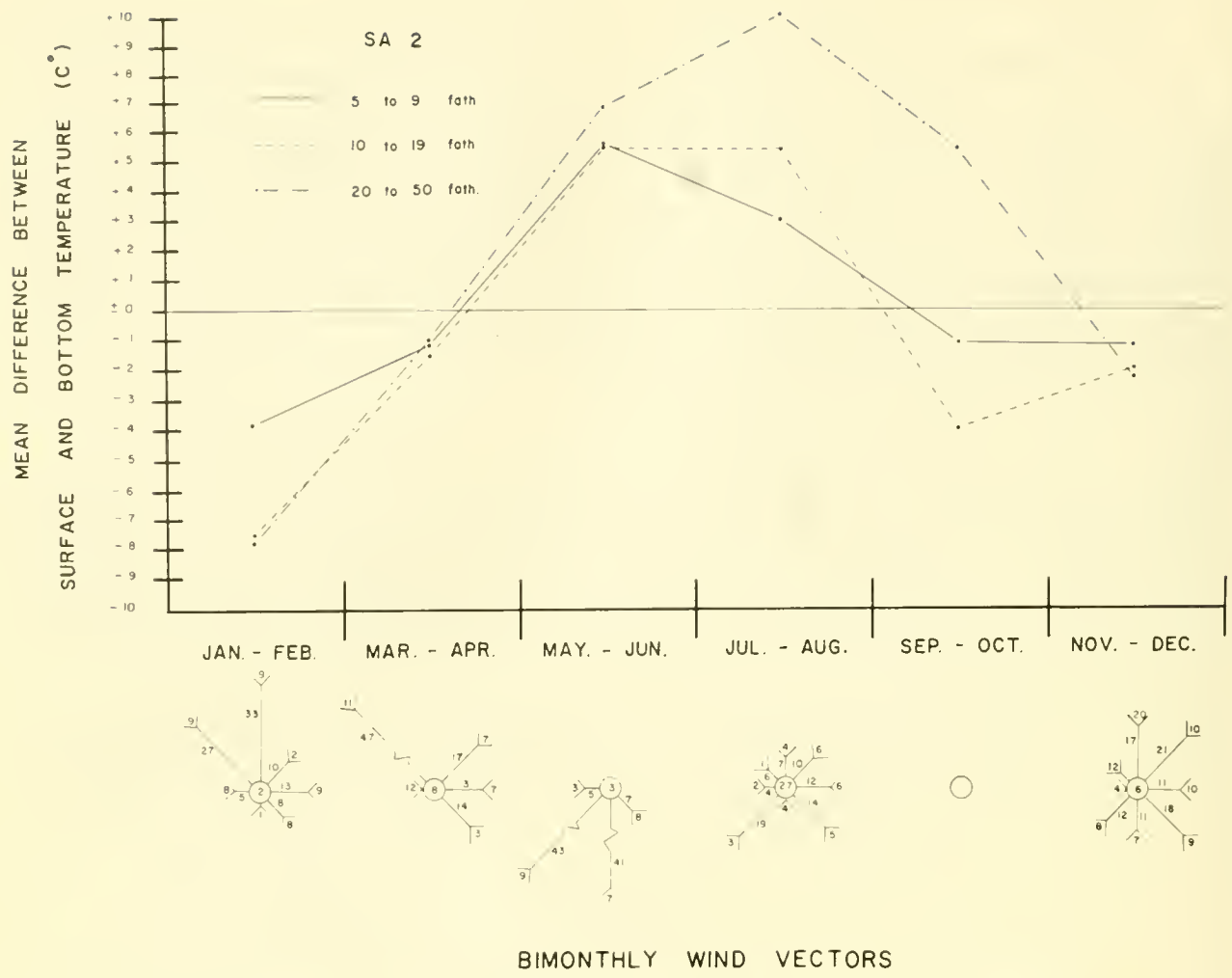

Figure 3.—Bimonthly mean difference between surface and bottom water temperatures and associated wind roses off the Mississippi River Delta (SA2). Wind roses: Arrows fly with the wind based on eight points of the compass. Each wind rose indicates the average wind speed at the end of the arrow, percent frequency at center of arrow, and percentage of calm or light winds are encircled.

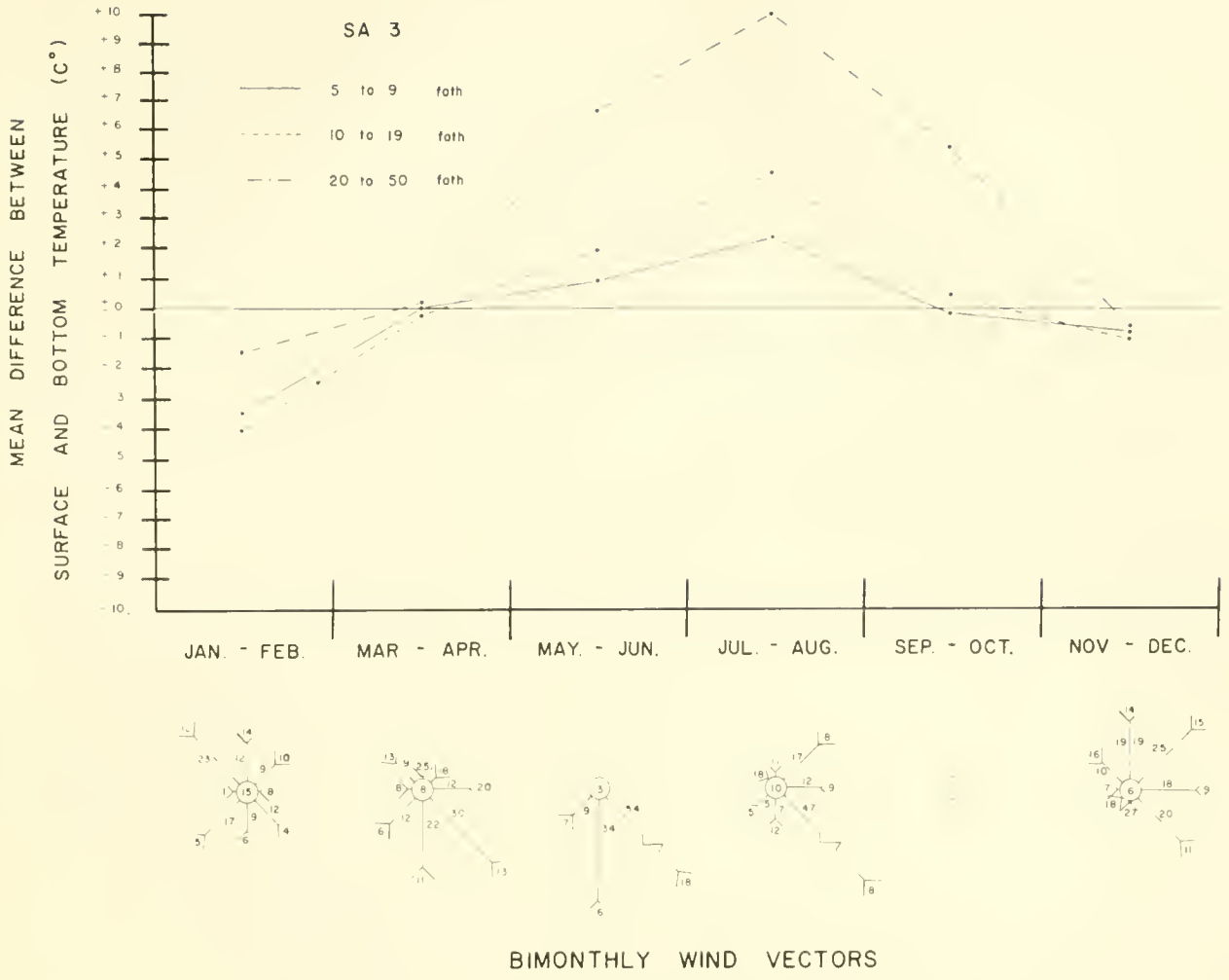

Figure 4.—Bimonthly mean difference between surface and bottom water temperatures and associated wind roses west of the Mississippi River Delta (SA3). Wind roses: Arrows fly with the wind based on eight points of the compass. Each wind rose indicates the average wind speed at the end of the arrow, percent frequency at center of arrow, and percentage of calm or light winds are encircled.

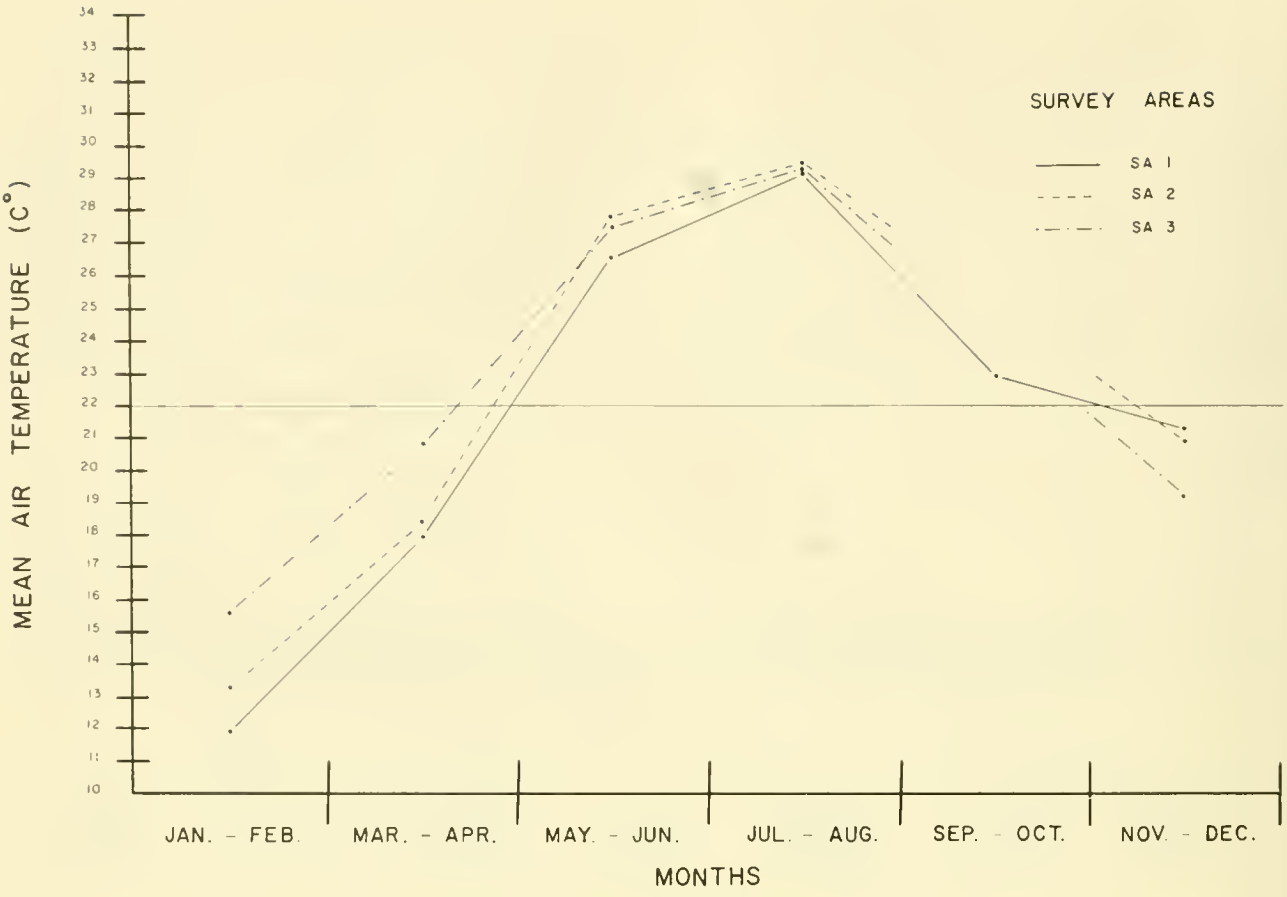

Figure 5.—Bimonthly mean air temperature for each survey area (SA1, 2 and 3).

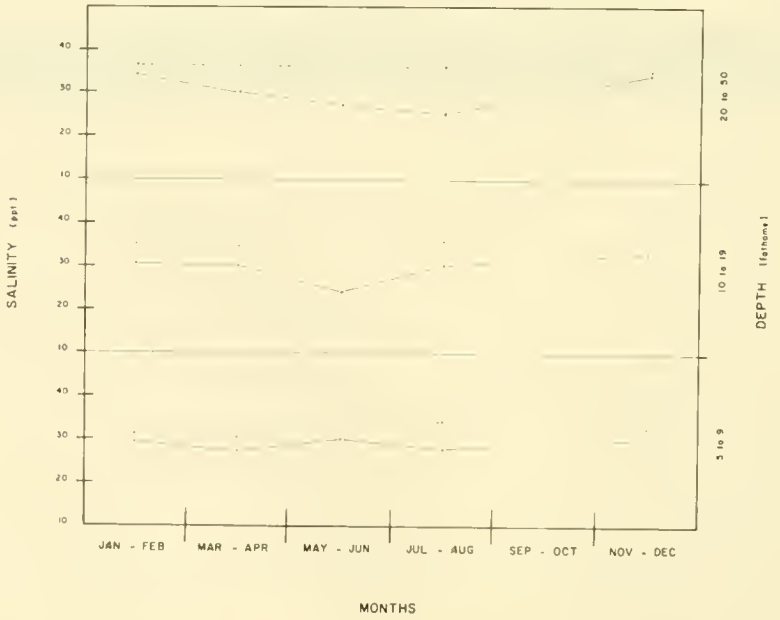

Figure 6.—Bimonthly mean surface and bottom salinity east of the Mississippi River Delta (SA1). Solid line is surface salinity; dash line is bottom salinity.

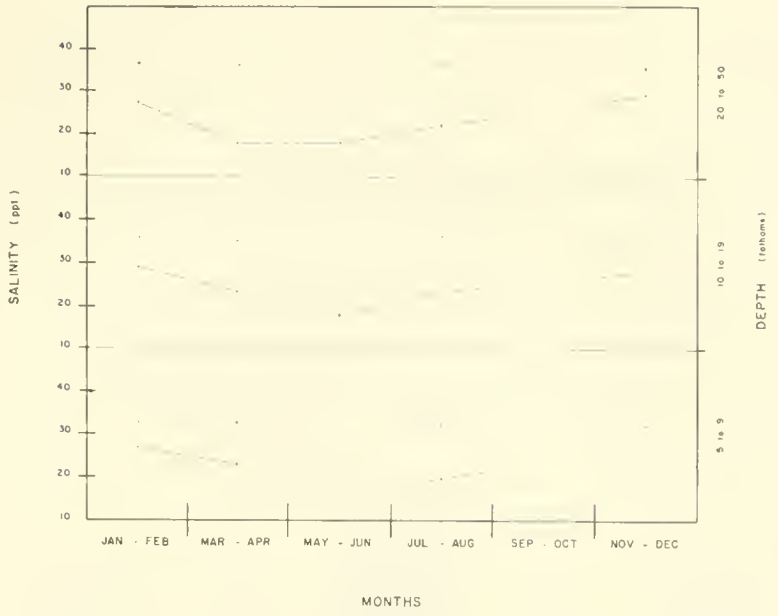

Figure 7.—Bimonthly mean surface and bottom salinity off the Mississippi River Delta (SA2). Solid line is surface salinity; dash line is bottom salinity.

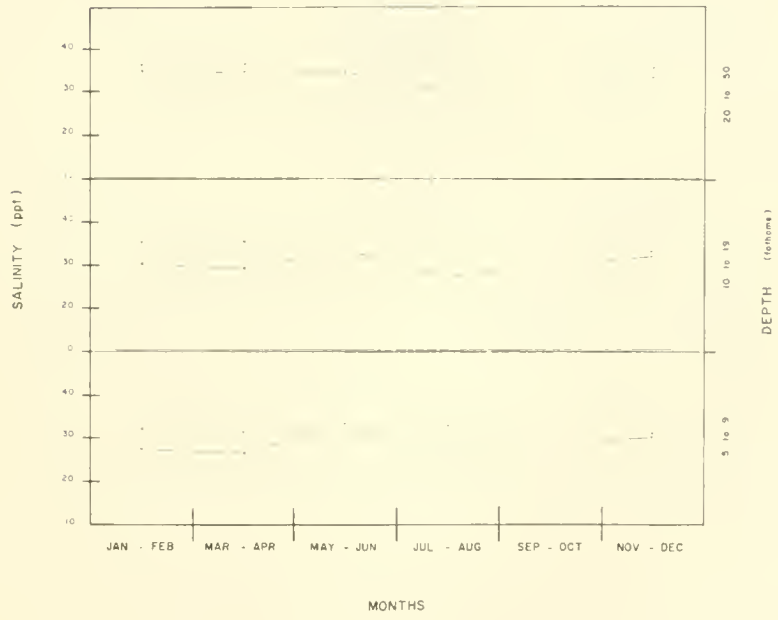

Figure 8.—Bimonthly mean surface and bottom salinity west of the Mississippi River Delta (SA3). Solid line is surface salinity; dash line is bottom salinity.

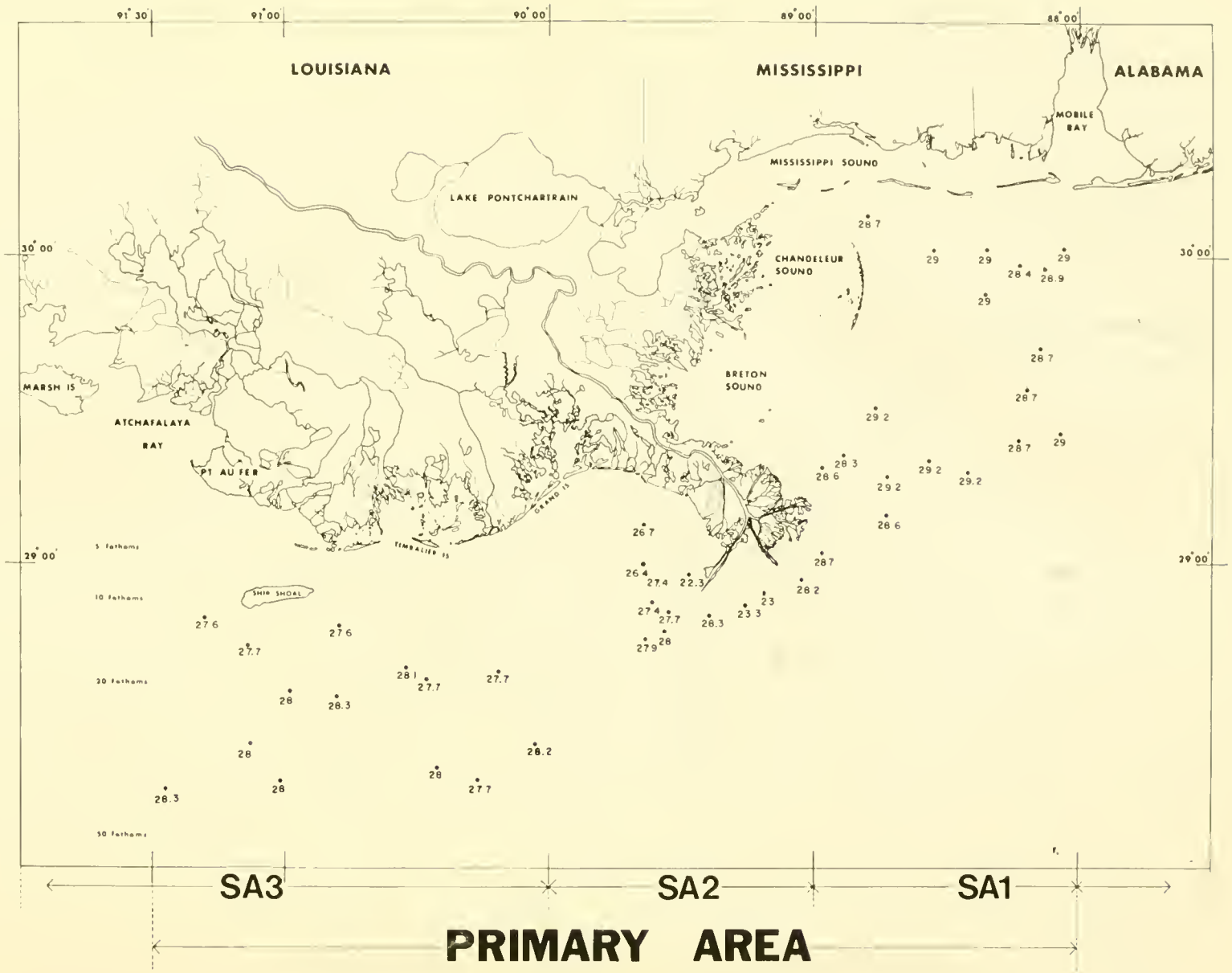

Figure 9.—Cruise 40, surface temperature (°C), October 1972.

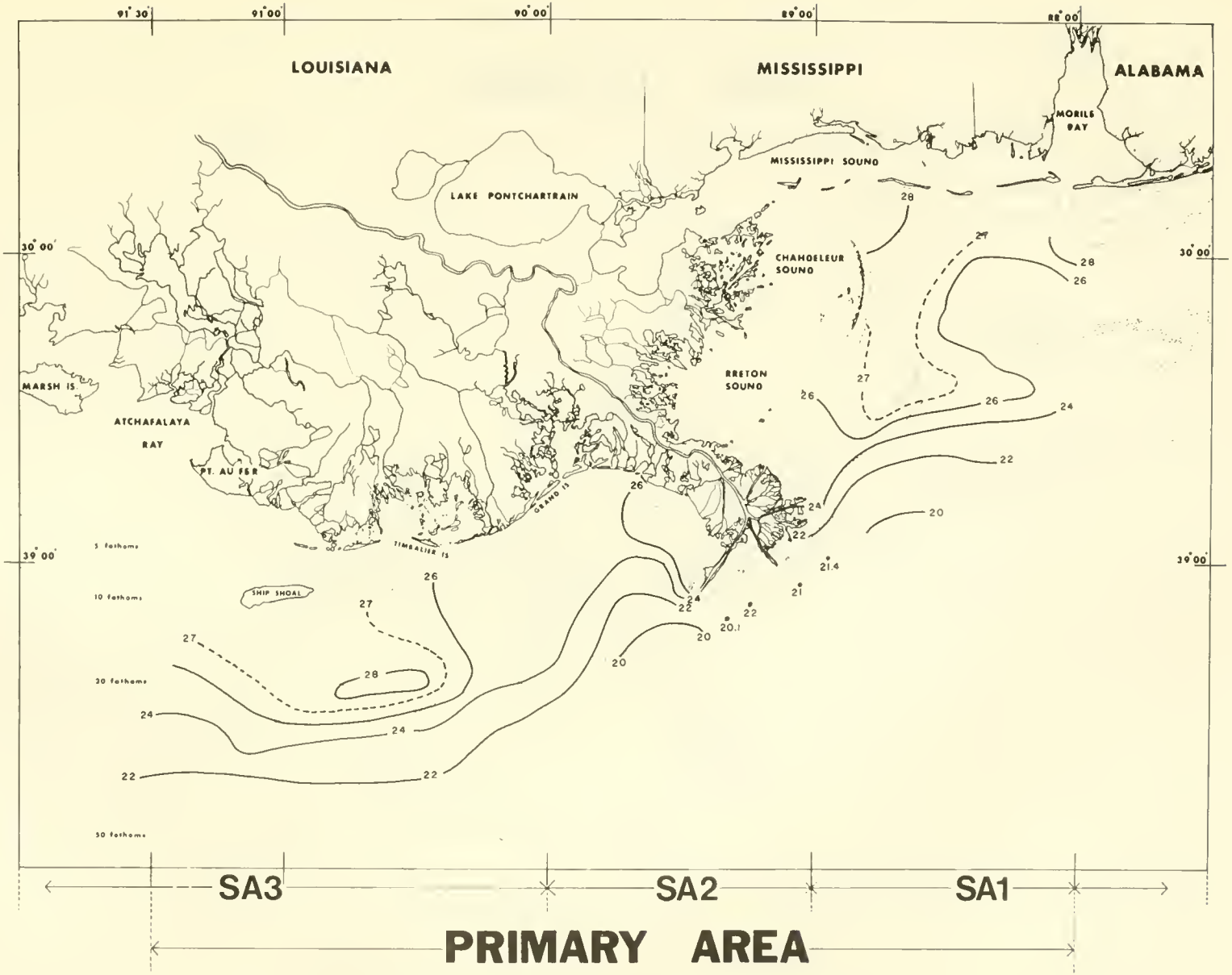

Figure 10.—Cruise 40, bottom temperature (°C), October 1972.

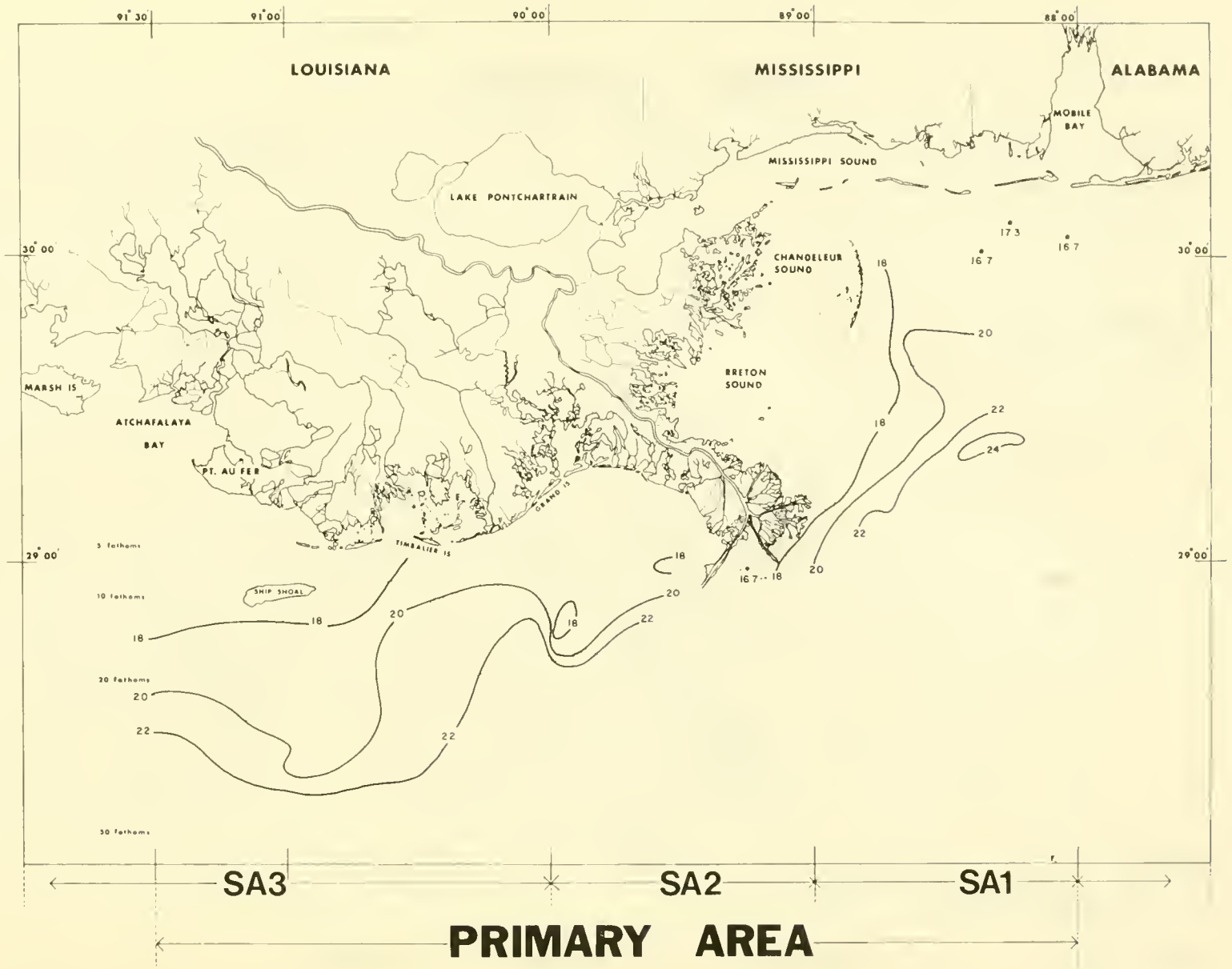

Figure 11.—Cruise 42, surface temperature (°C), November 1972.

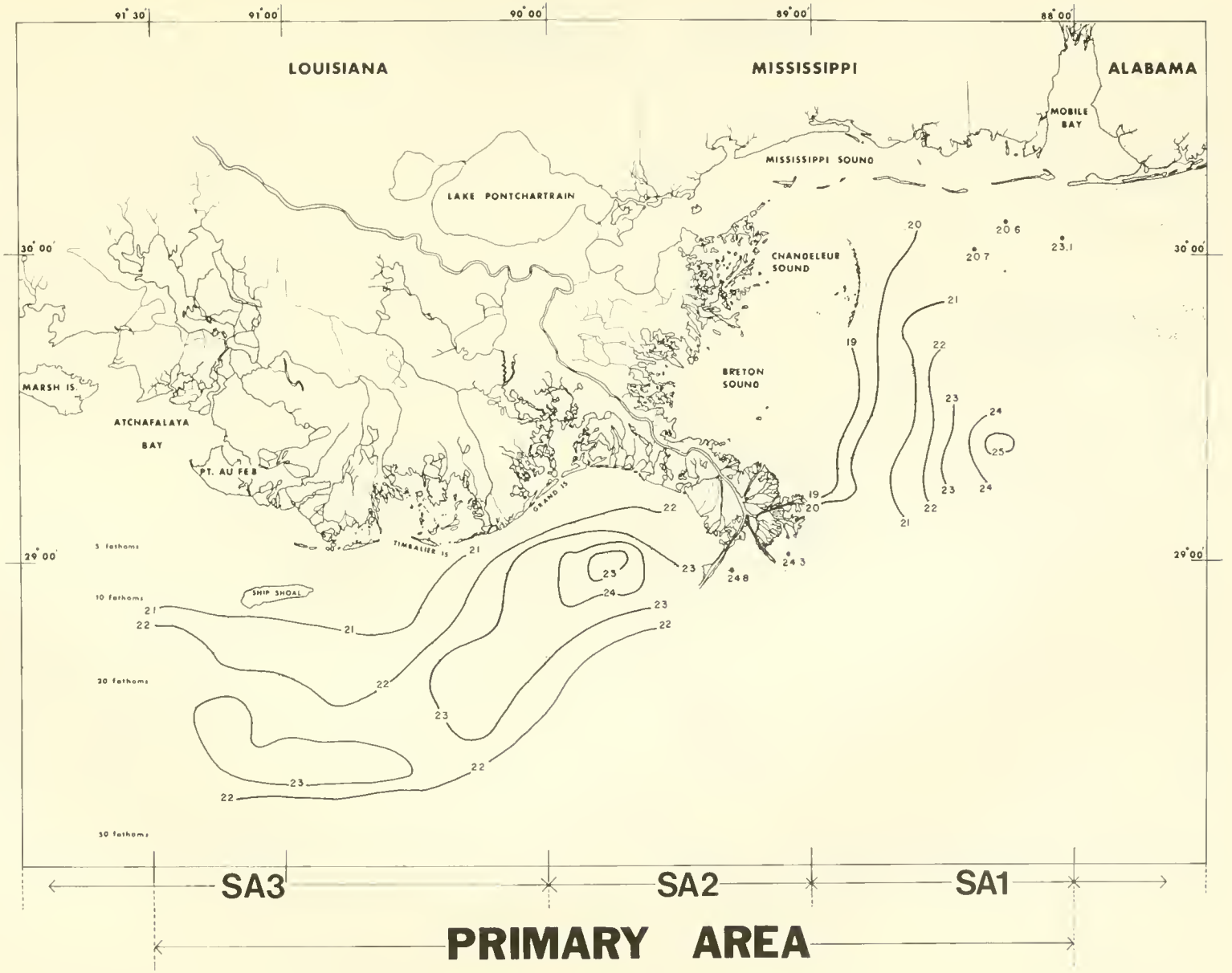

Figure 12.—Cruise 42, bottom temperature (°C), November 1972.

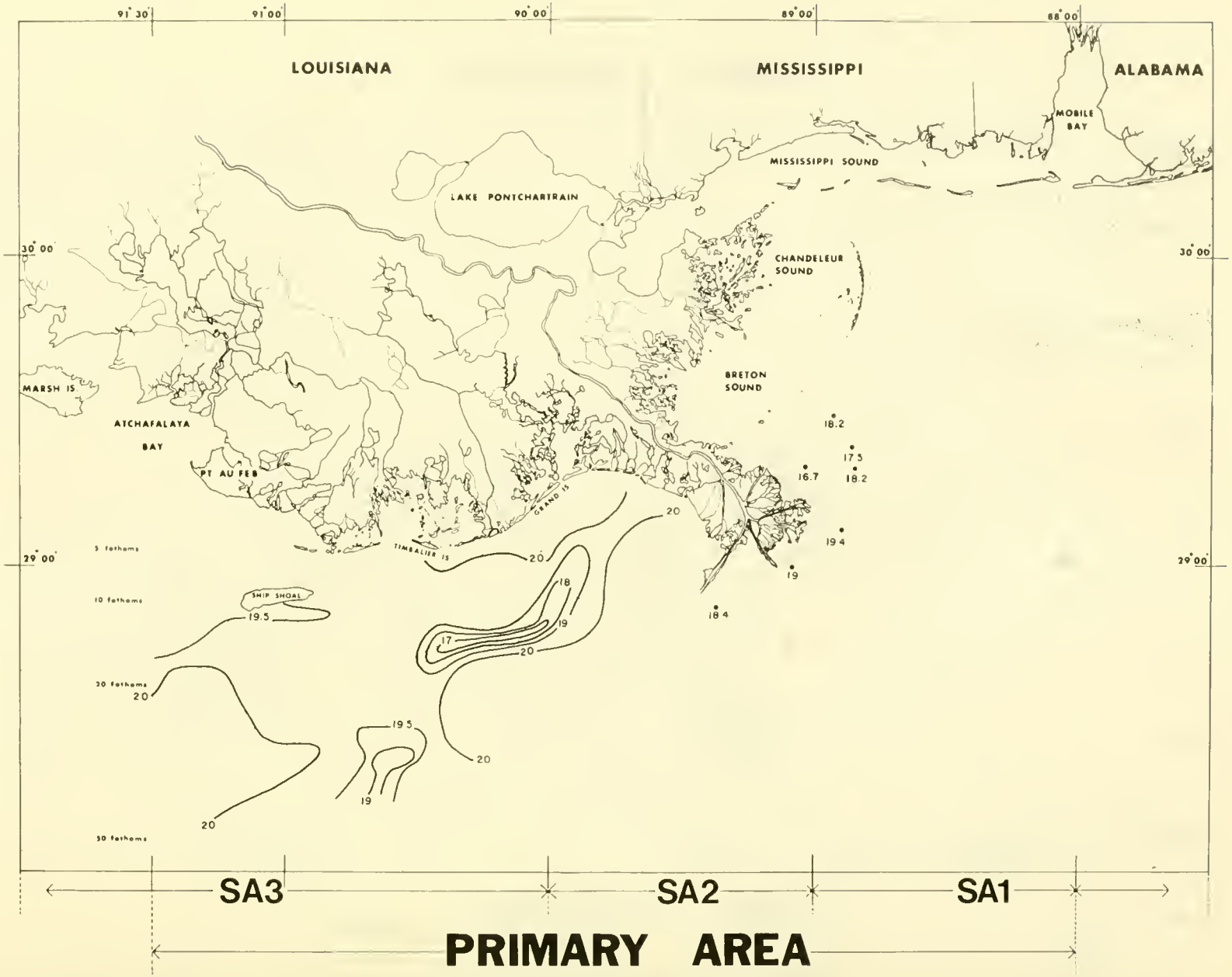

Figure 13.—Cruise 44, surface temperature (°C), April 1973.

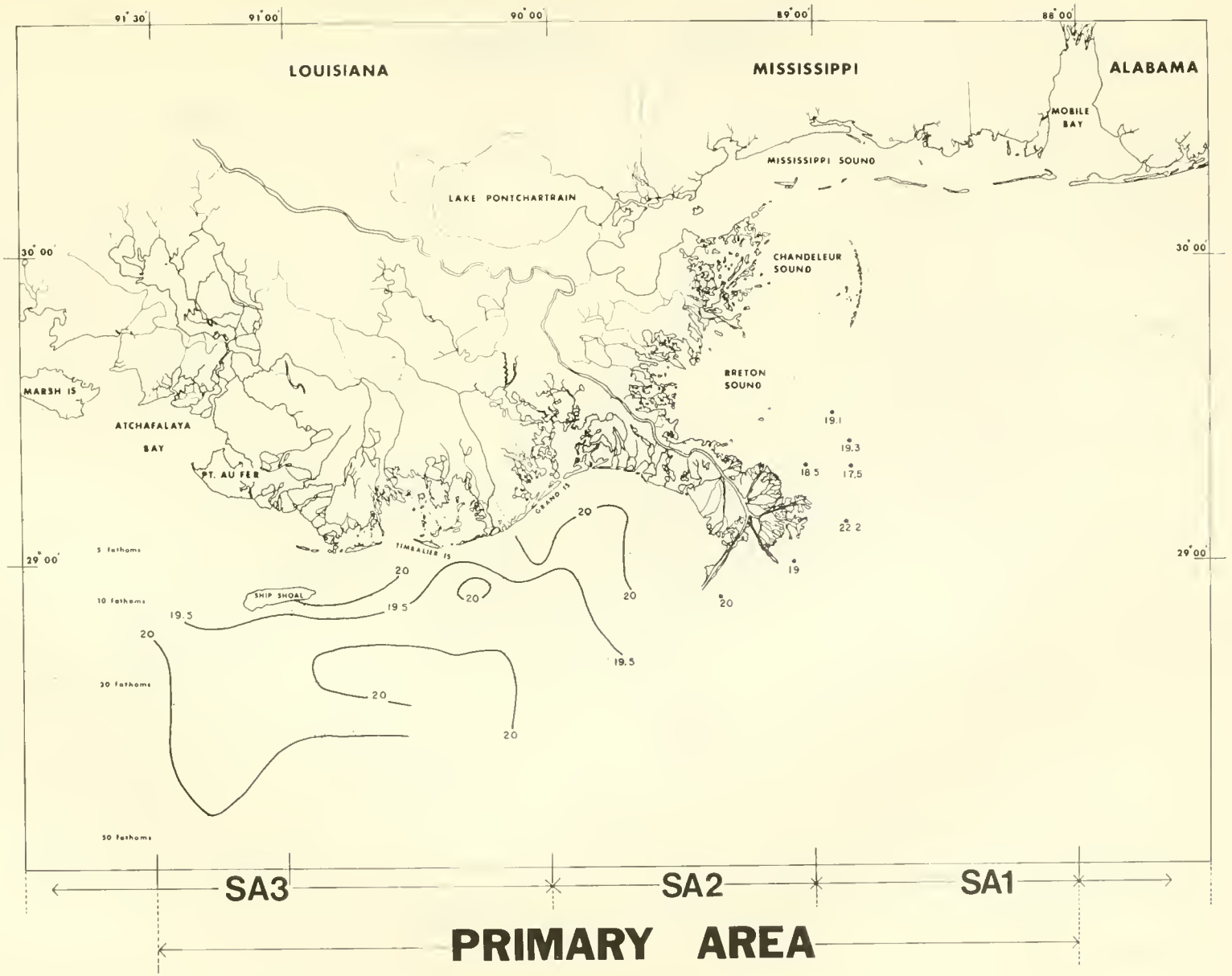

Figure 14.—Cruise 44, bottom temperature (°C), April 1973.

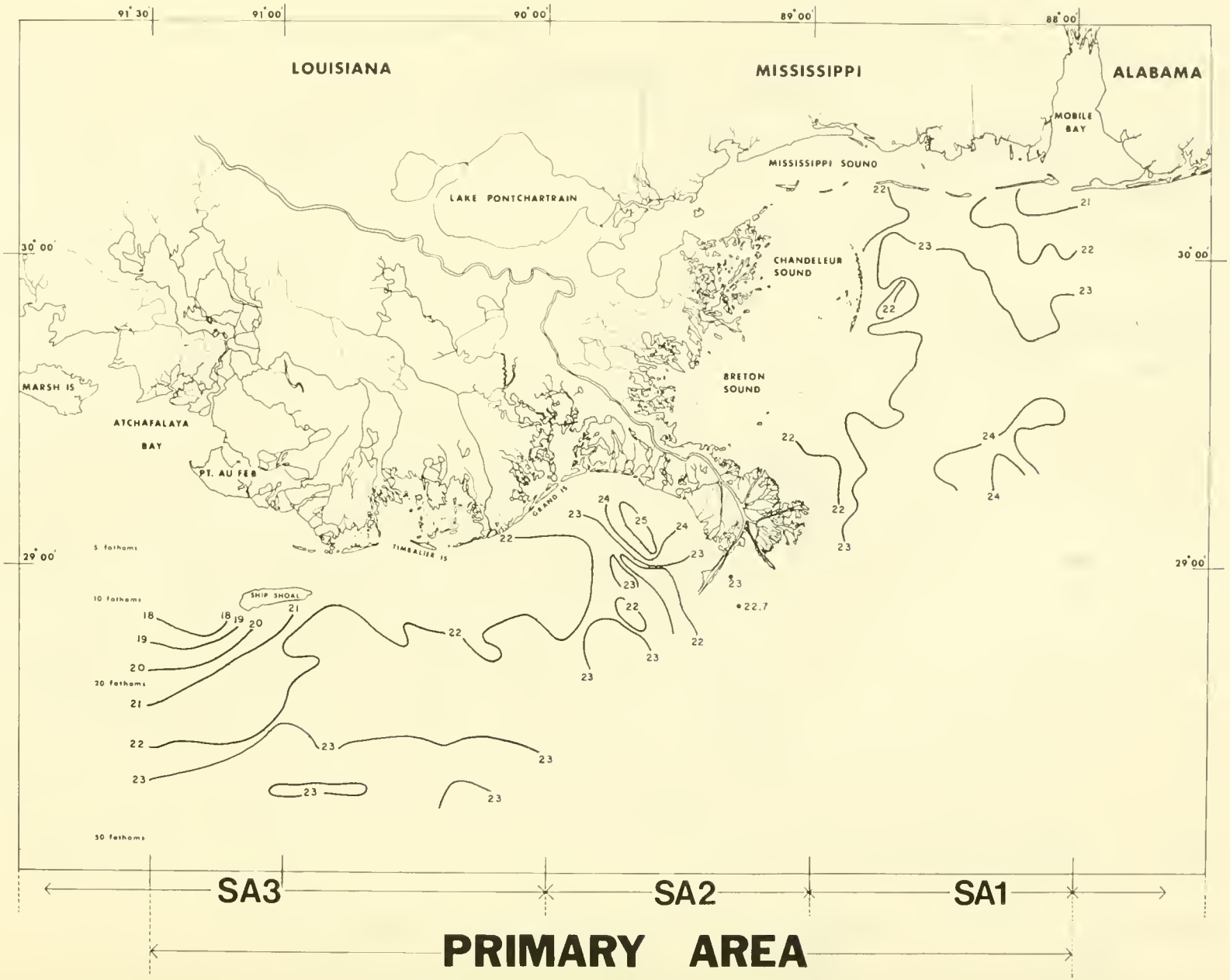

Figure 15.—Cruise 48, surface temperature (°C), November 1973.

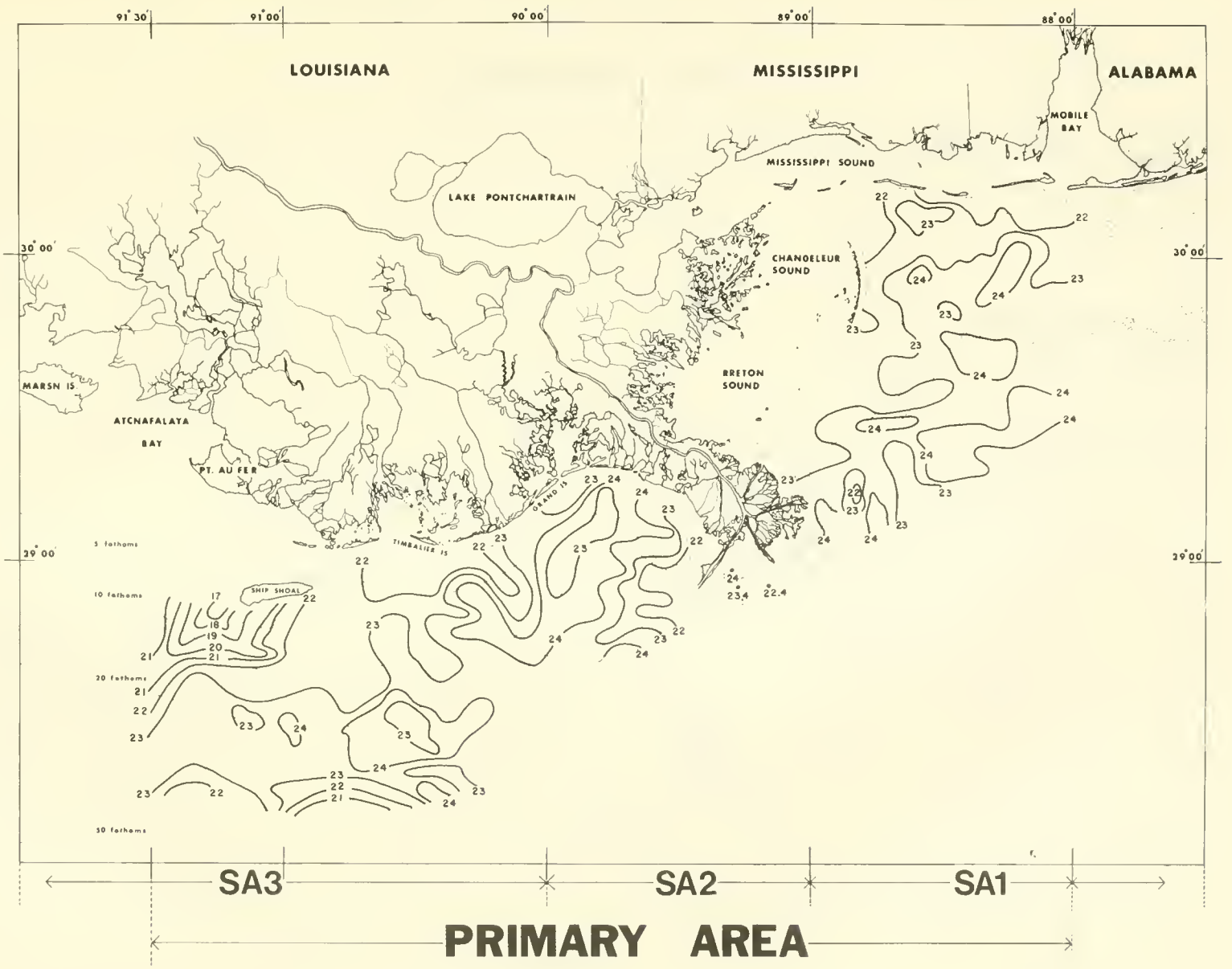

Figure 16.—Cruise 48, bottom temperature (°C), November 1973.

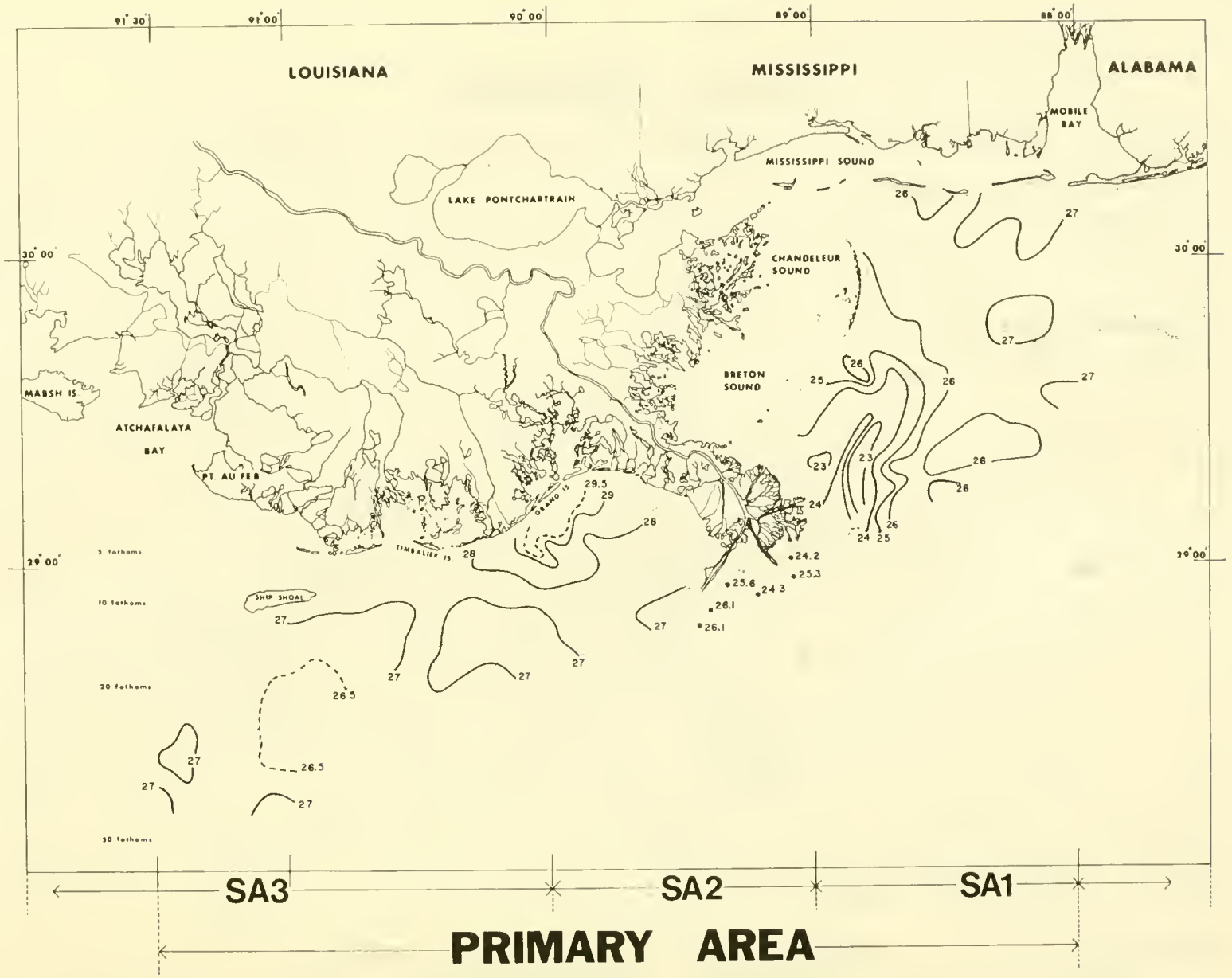

Figure 17.—Cruise 51, surface temperature (°C), June 1974.

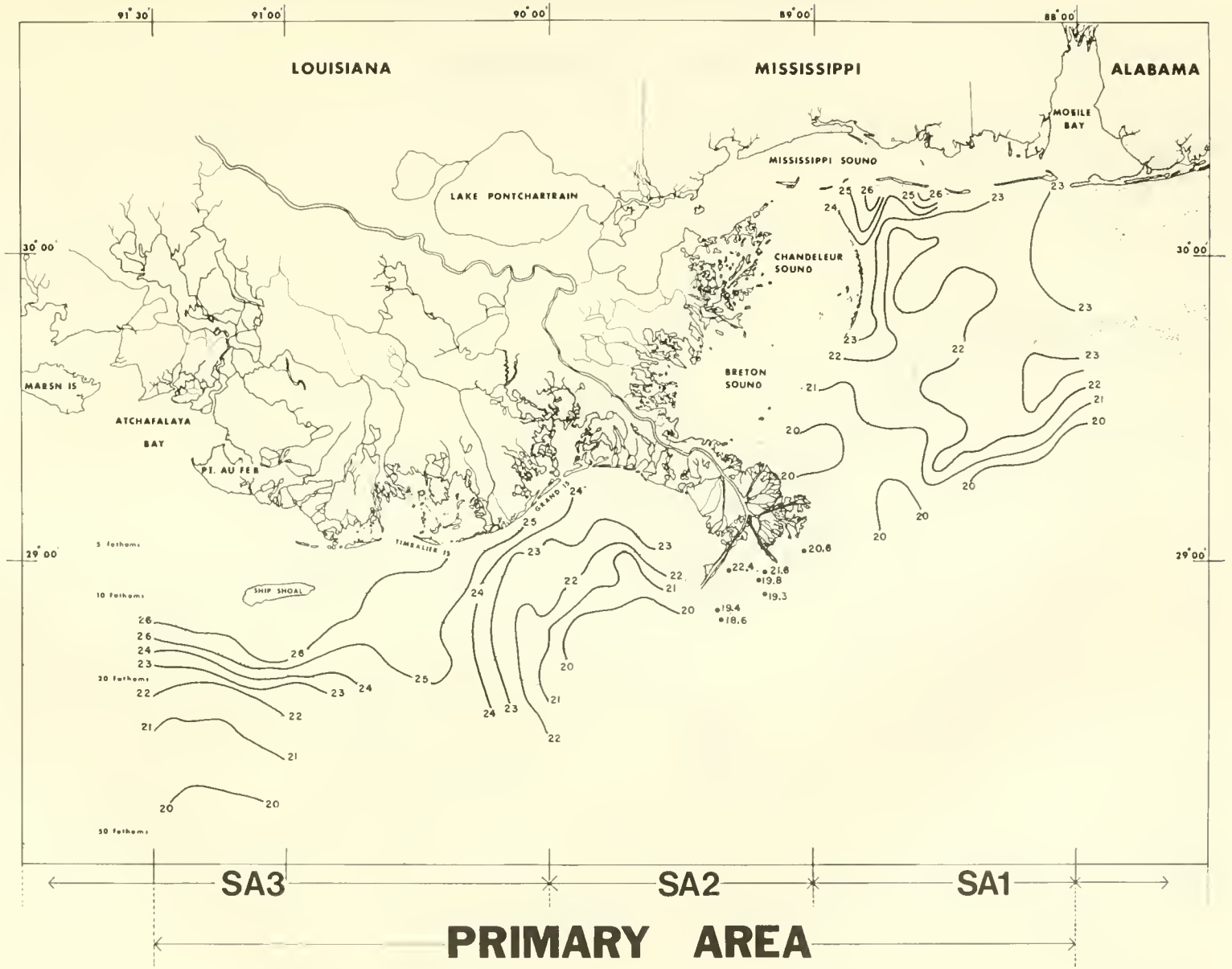

Figure 18.—Cruise 51, bottom temperature (°C), June 1974.

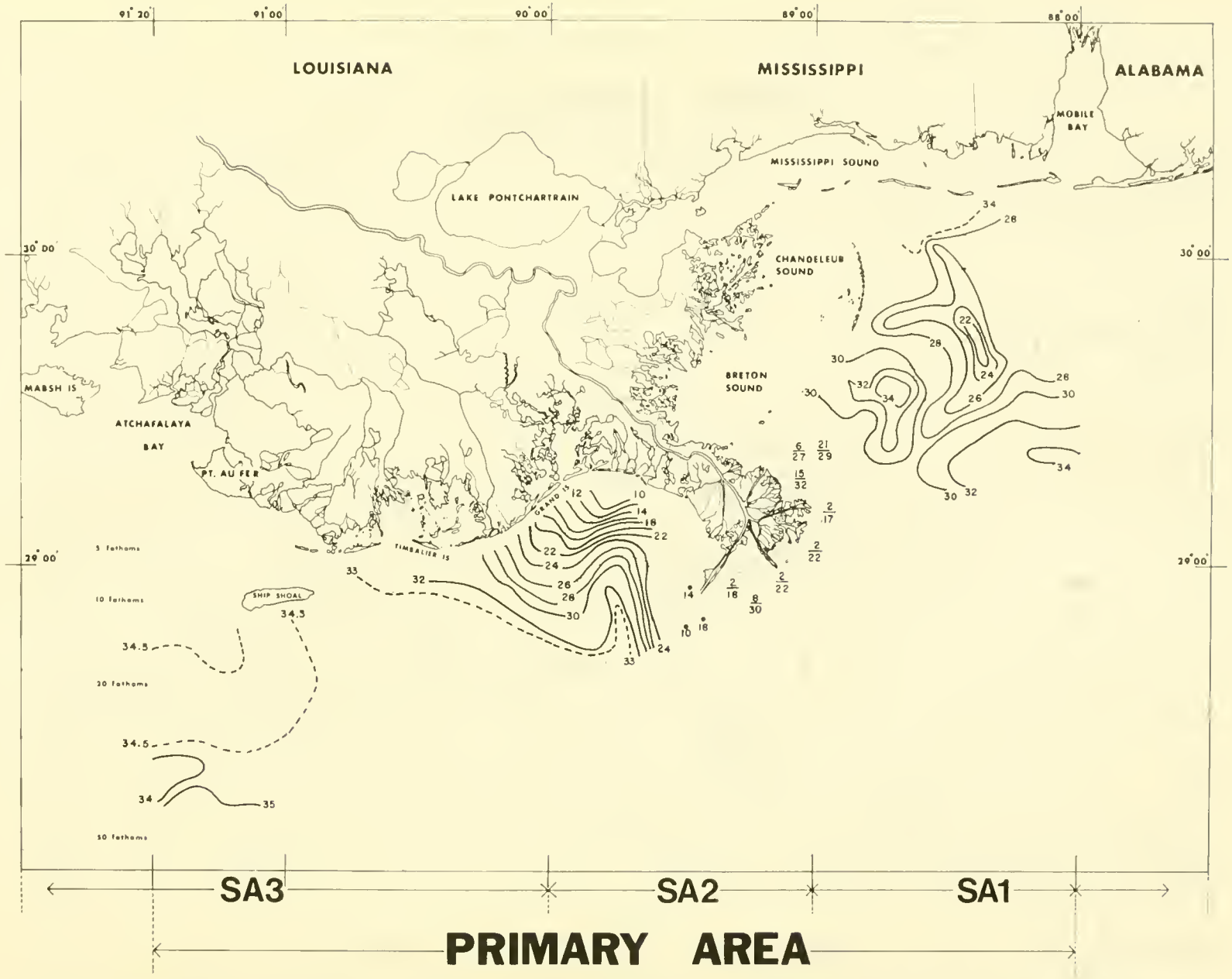

Figure 19.—Cruise 51, surface salinity (ppt), June 1974. Salinity data points off the Mississippi River are represented by two numbers. The upper number indicates surface salinity; the lower number is subsurface salinity taken from 1 m below the surface.

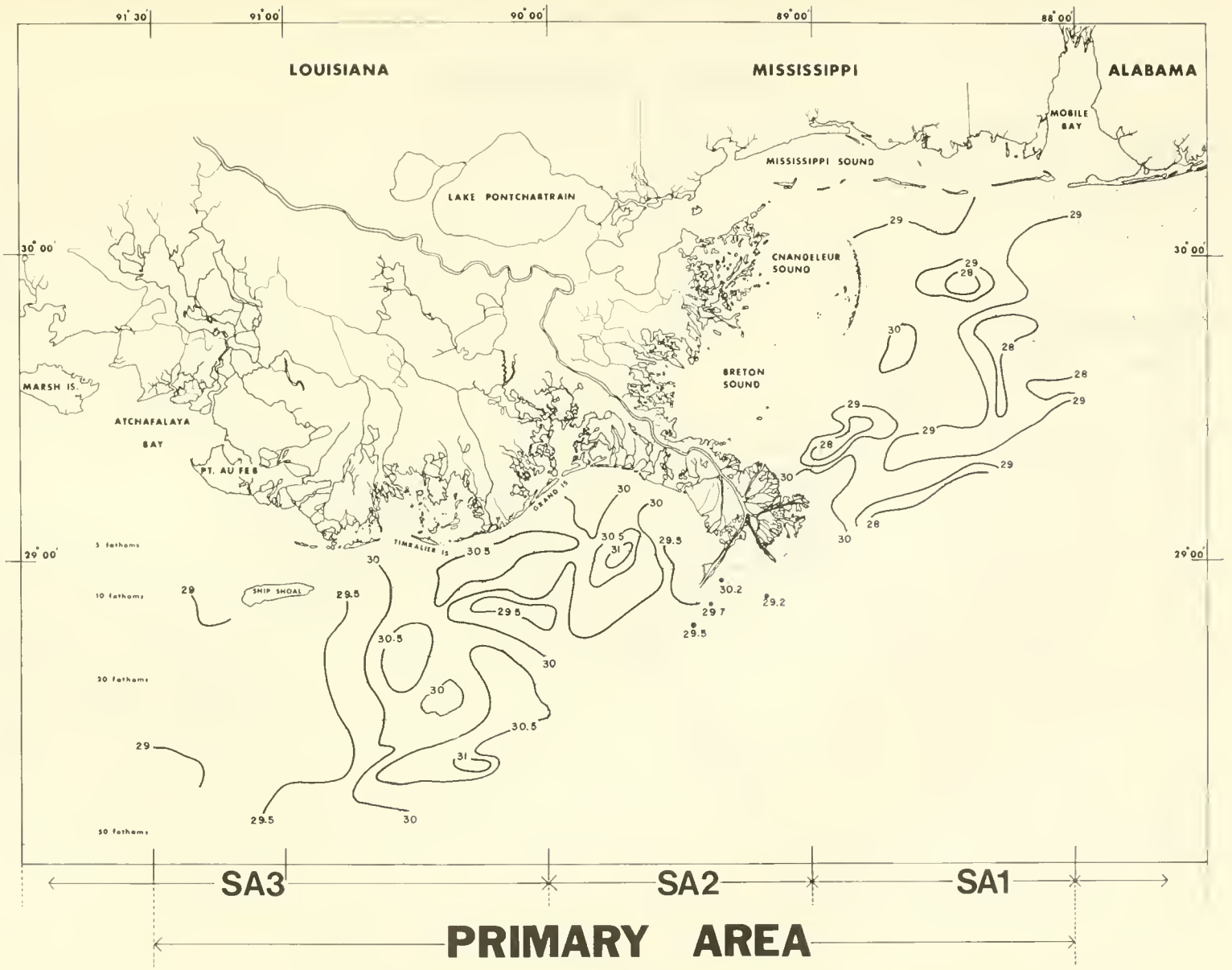

Figure 20.—Cruise 52, surface temperature (°C), August 1974.

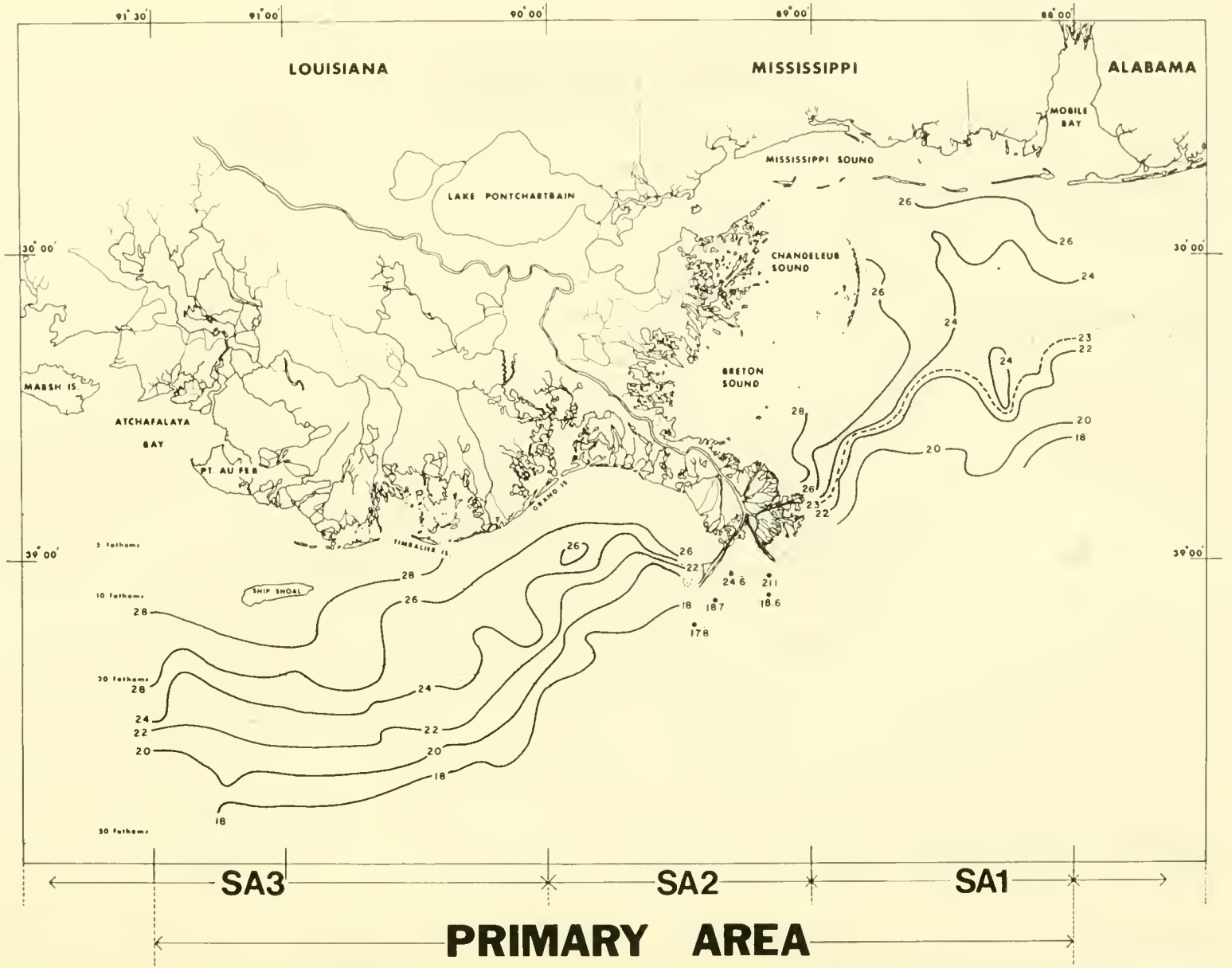

Figure 21.—Cruise 52, bottom temperature (°C), August 1974.

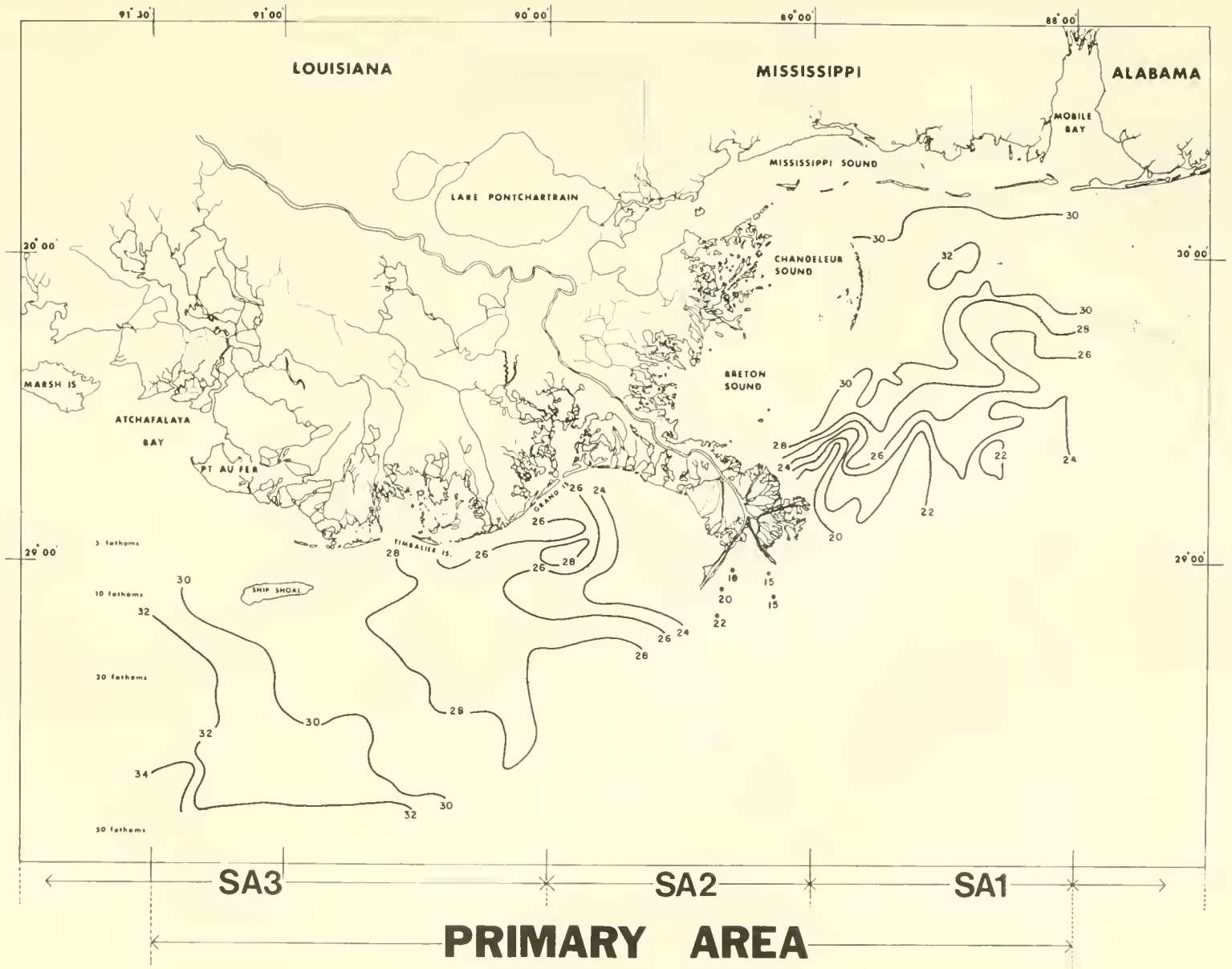

Figure 22.—Cruise 52, surface salinity (ppt), August 1974.

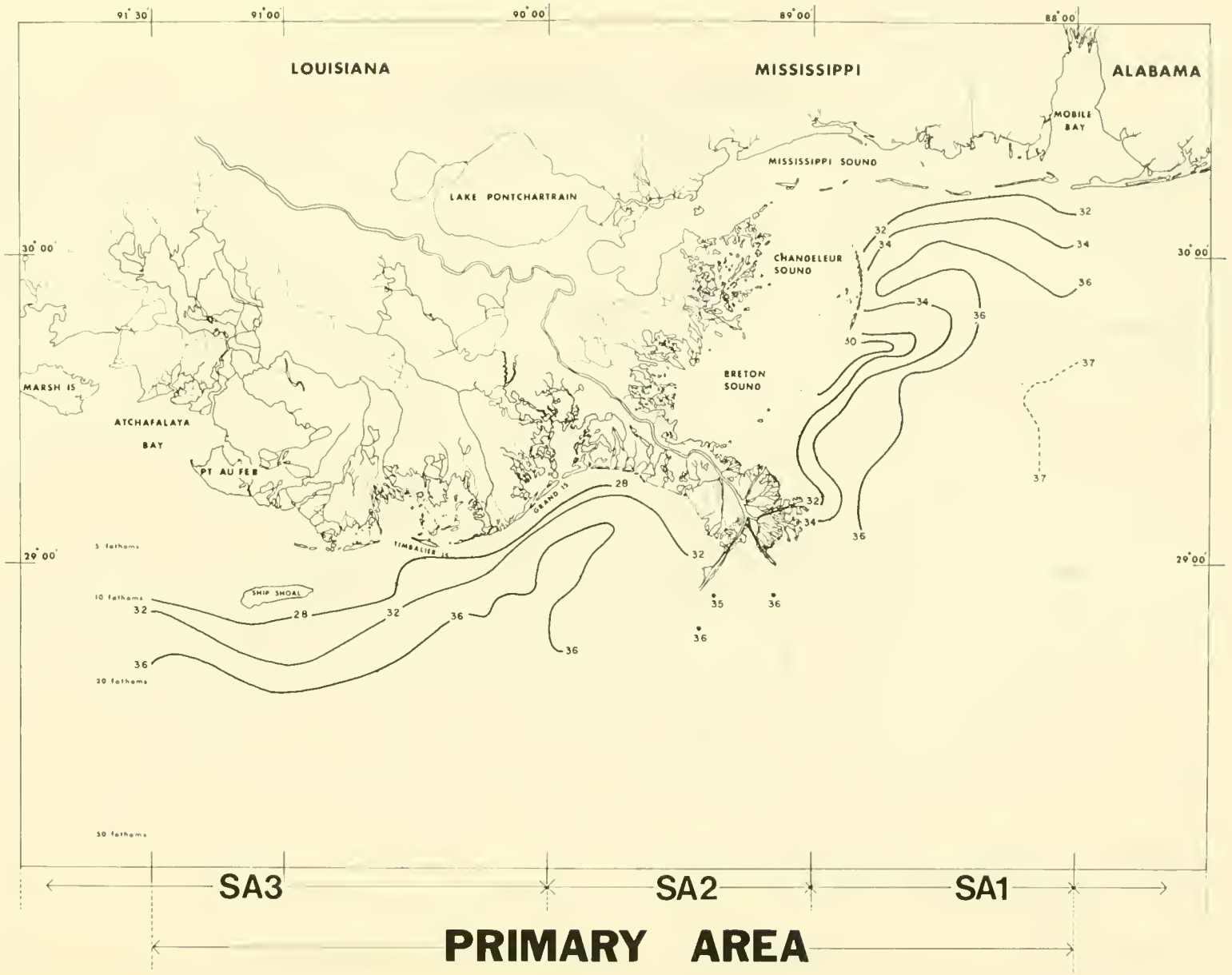

Figure 23.—Cruise 52, bottom salinity (ppt), August 1974.

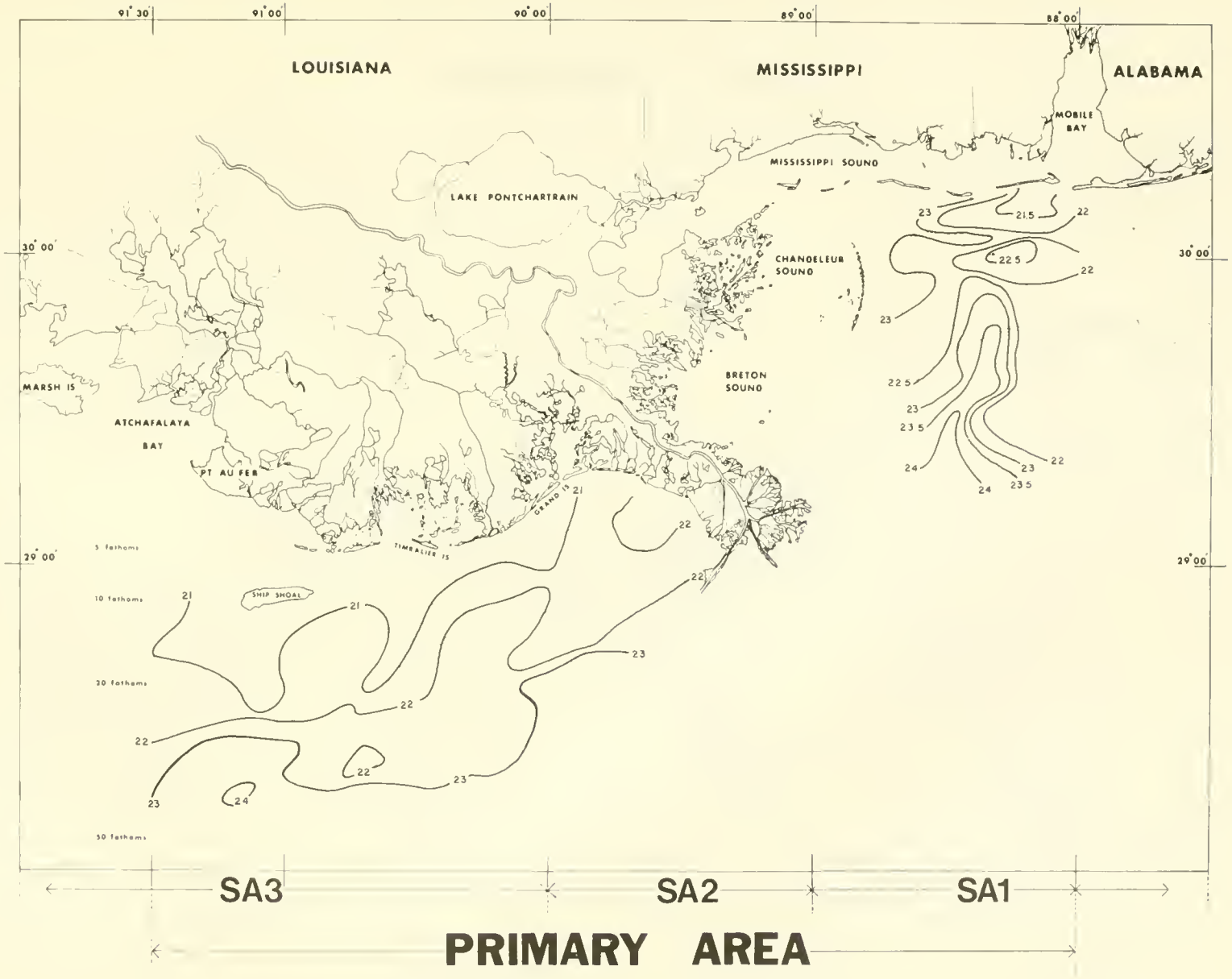

Figure 24.—Cruise 55, surface temperature (°C), November 1974.

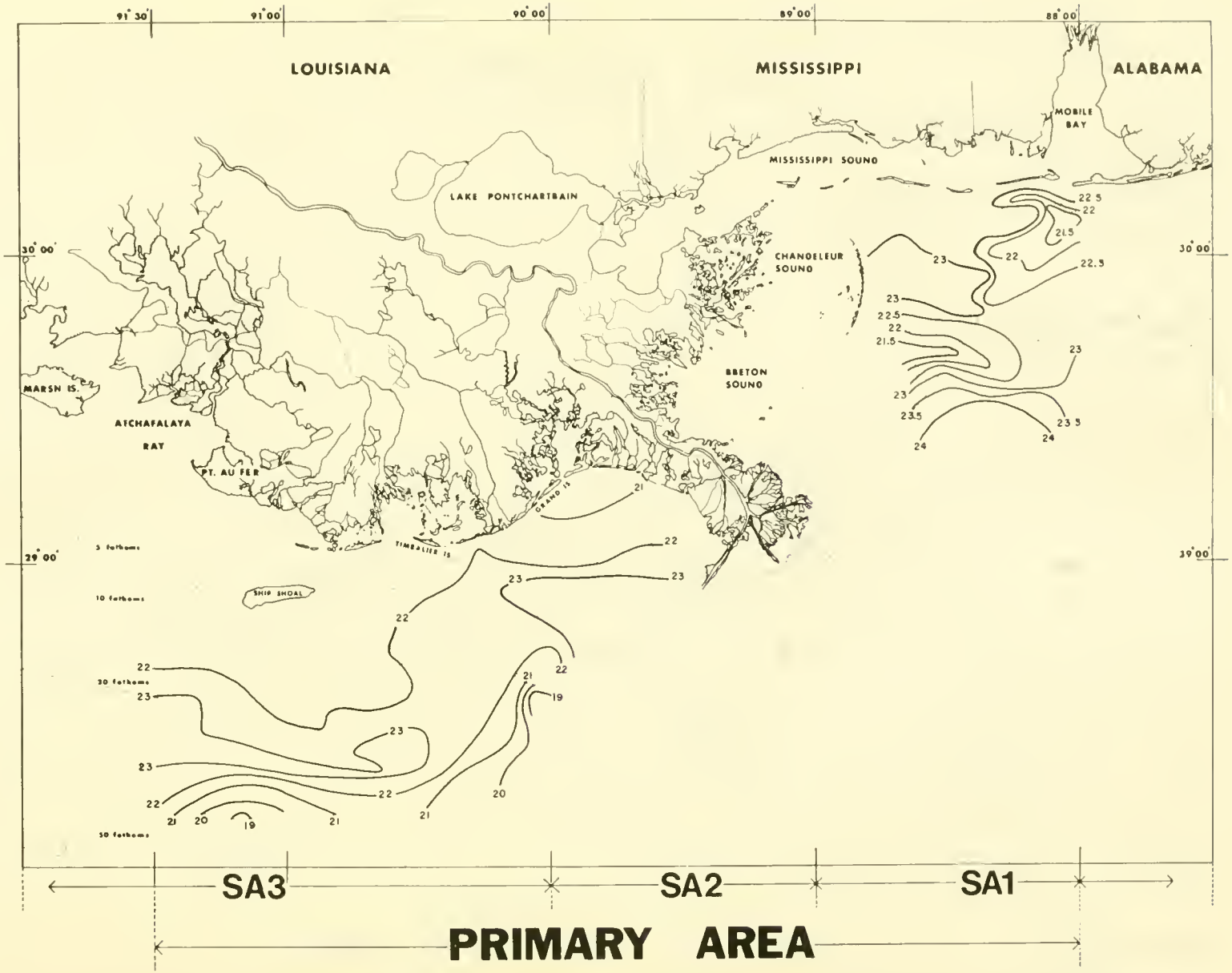

Figure 25.—Cruise 55, bottom temperature (°C), November 1974.

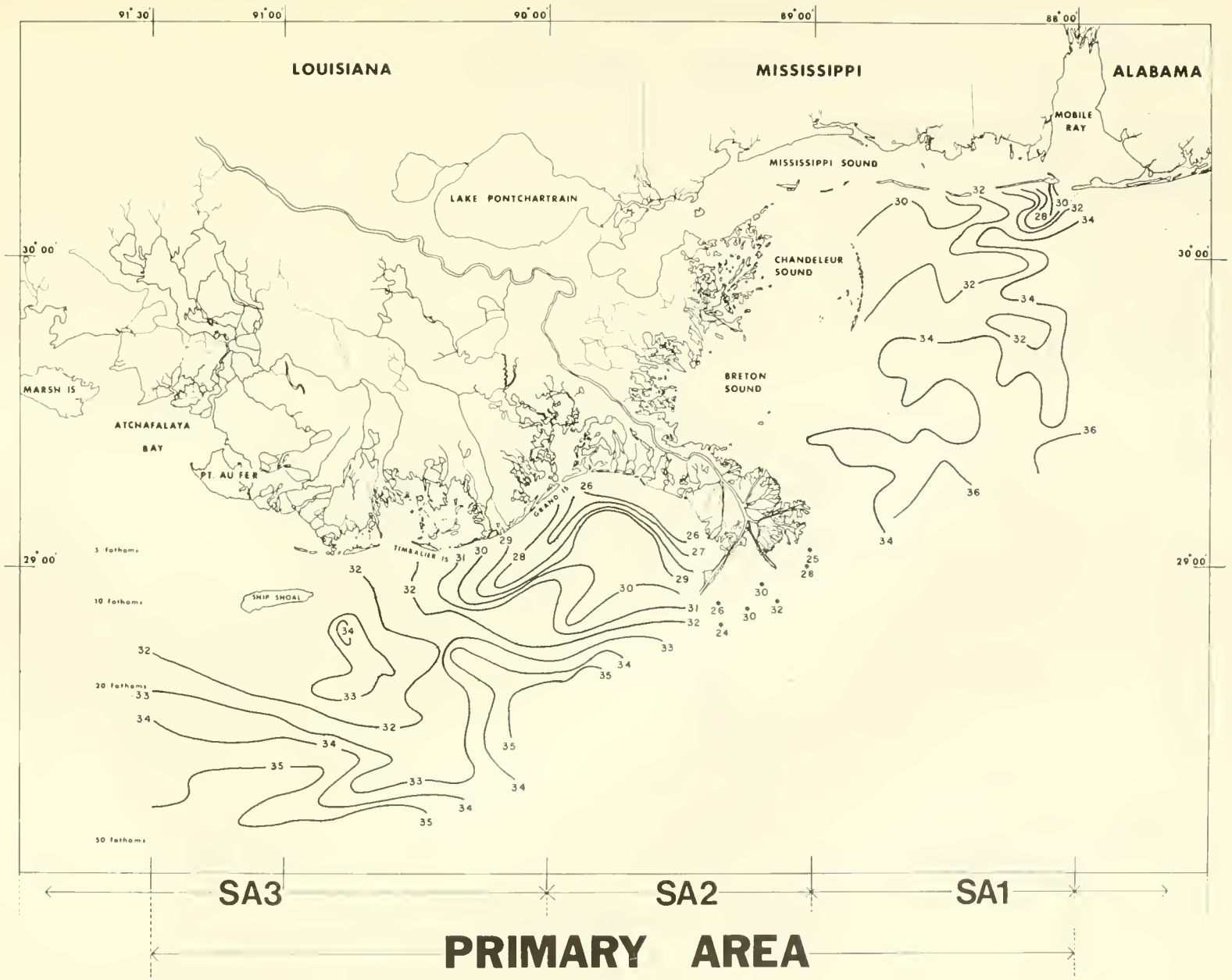

Figure 26.—Cruise 55, surface salinity (ppt), November 1974.

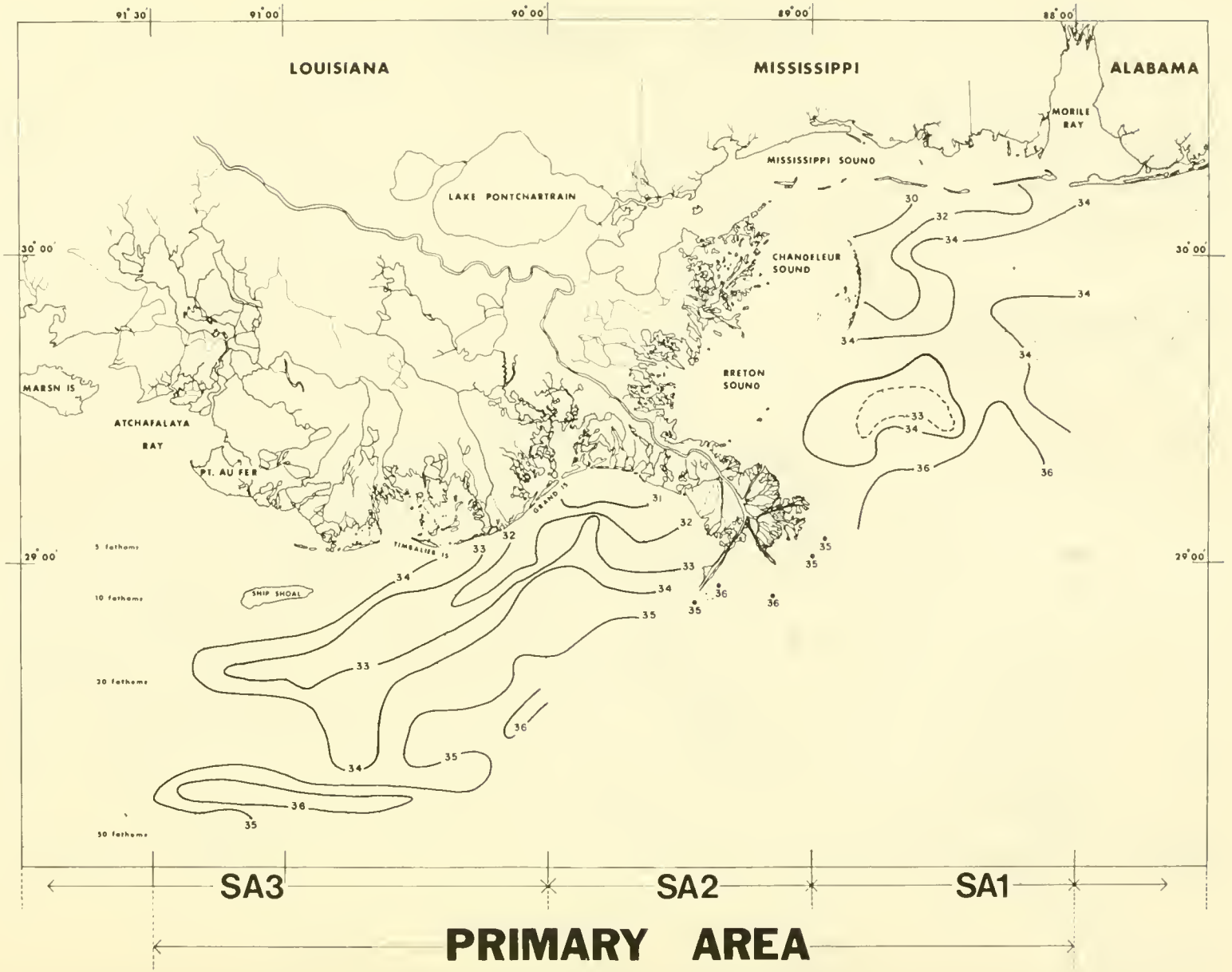

Figure 27.—Cruise 55, bottom salinity (ppt), November 1974.

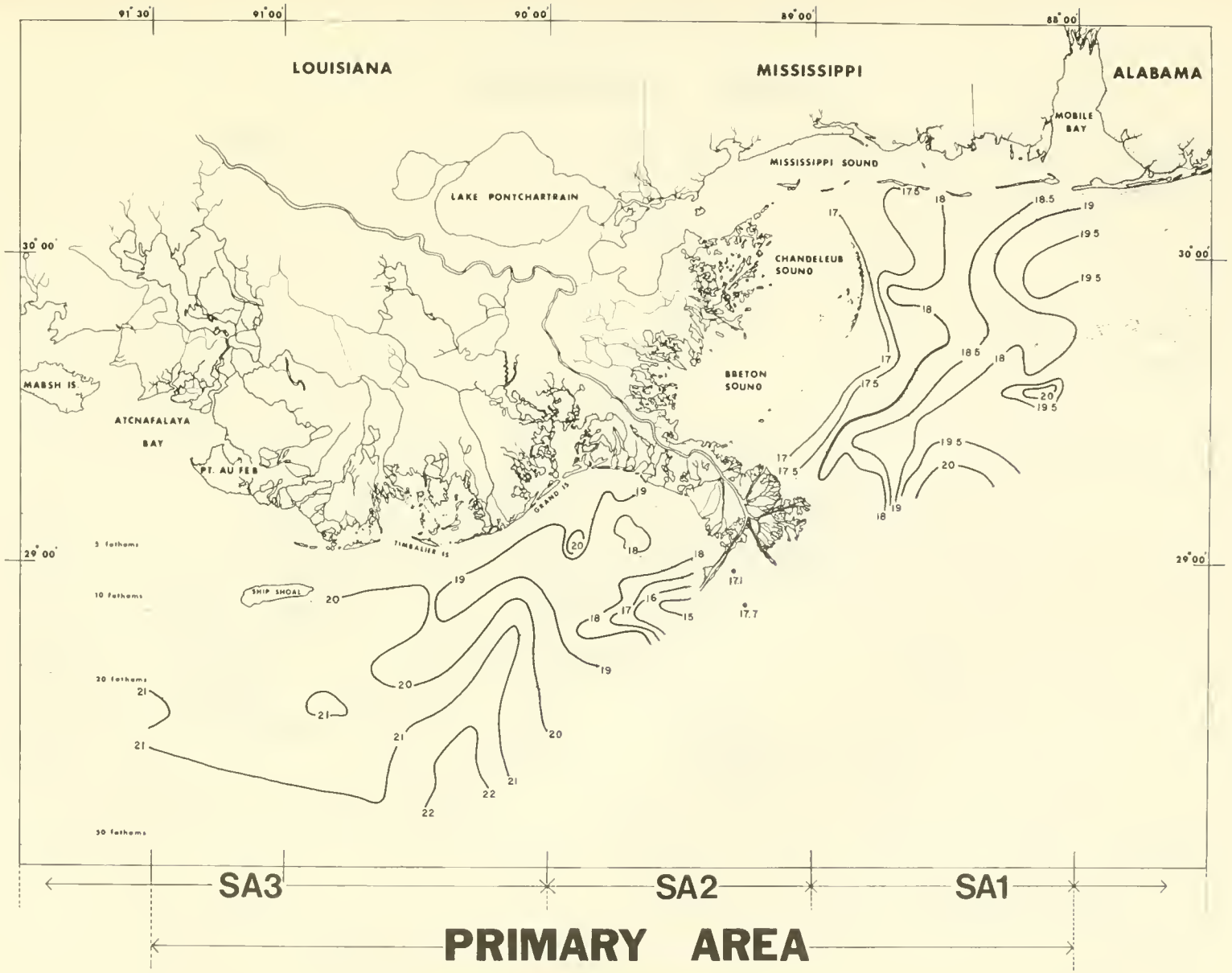

Figure 28.—Cruise 57, surface temperature (°C), March 1975.

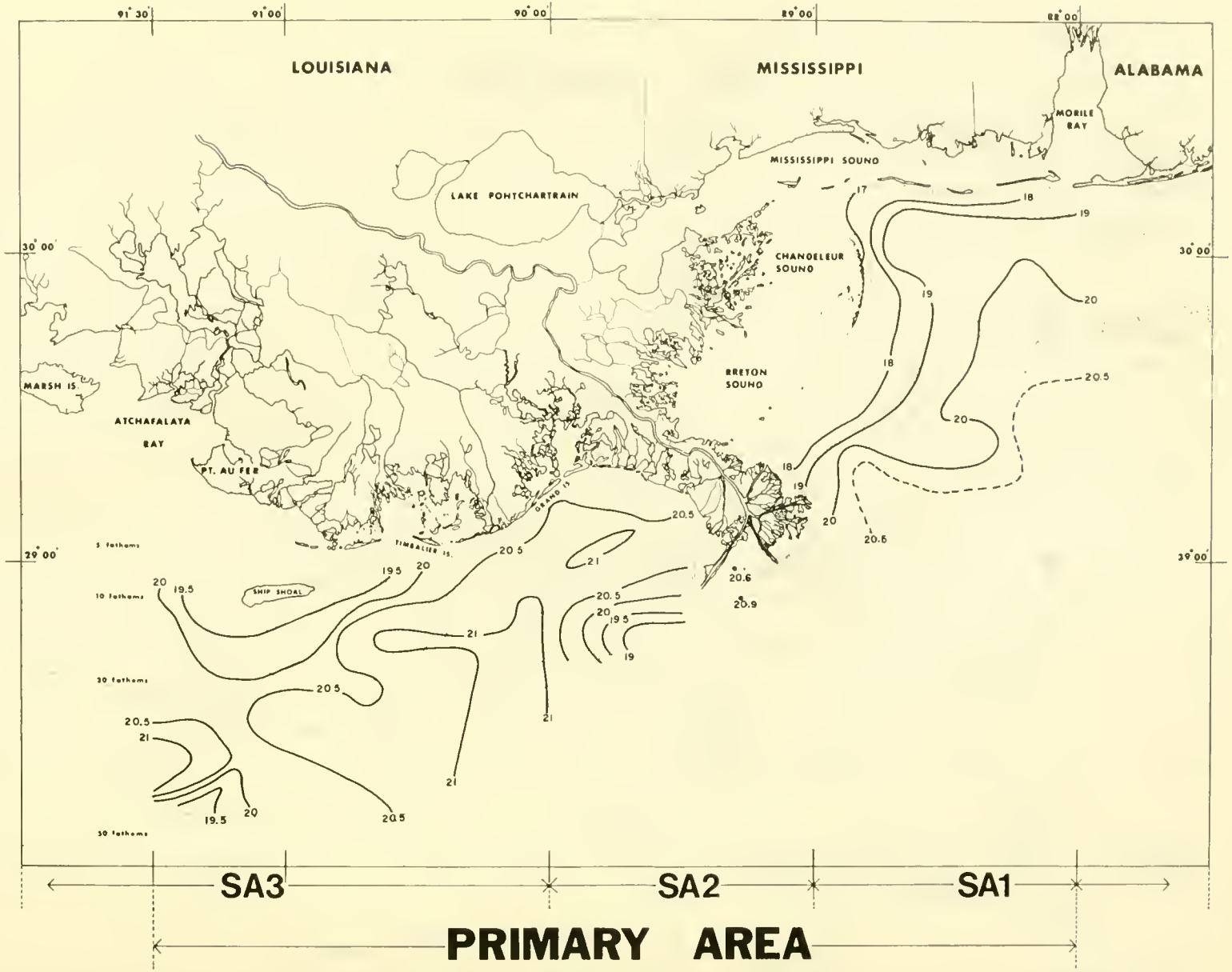

Figure 29.—Cruise 57, bottom temperature (°C), March 1975.

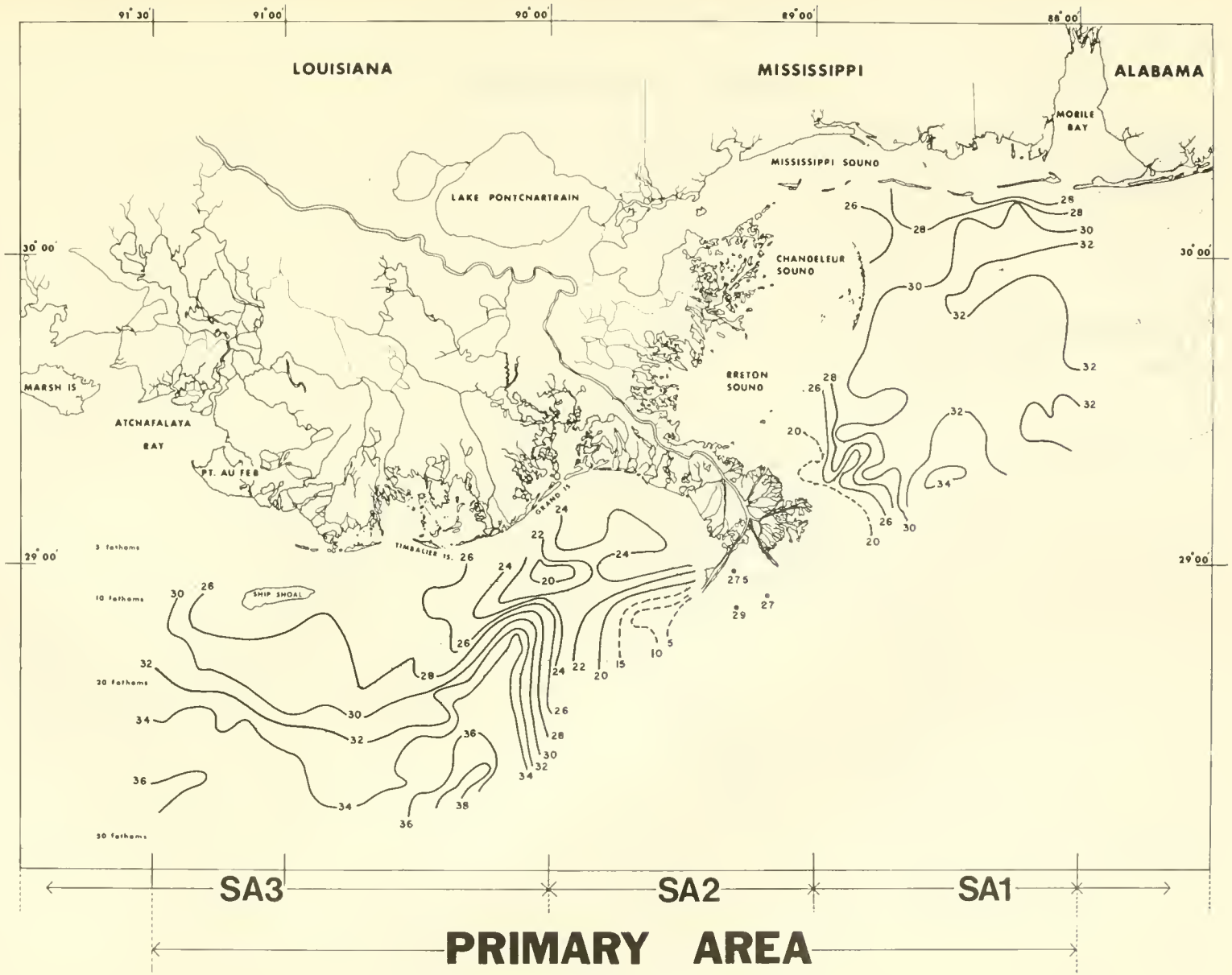

Figure 30.—Cruise 57, surface salinity (ppt), March 1975.

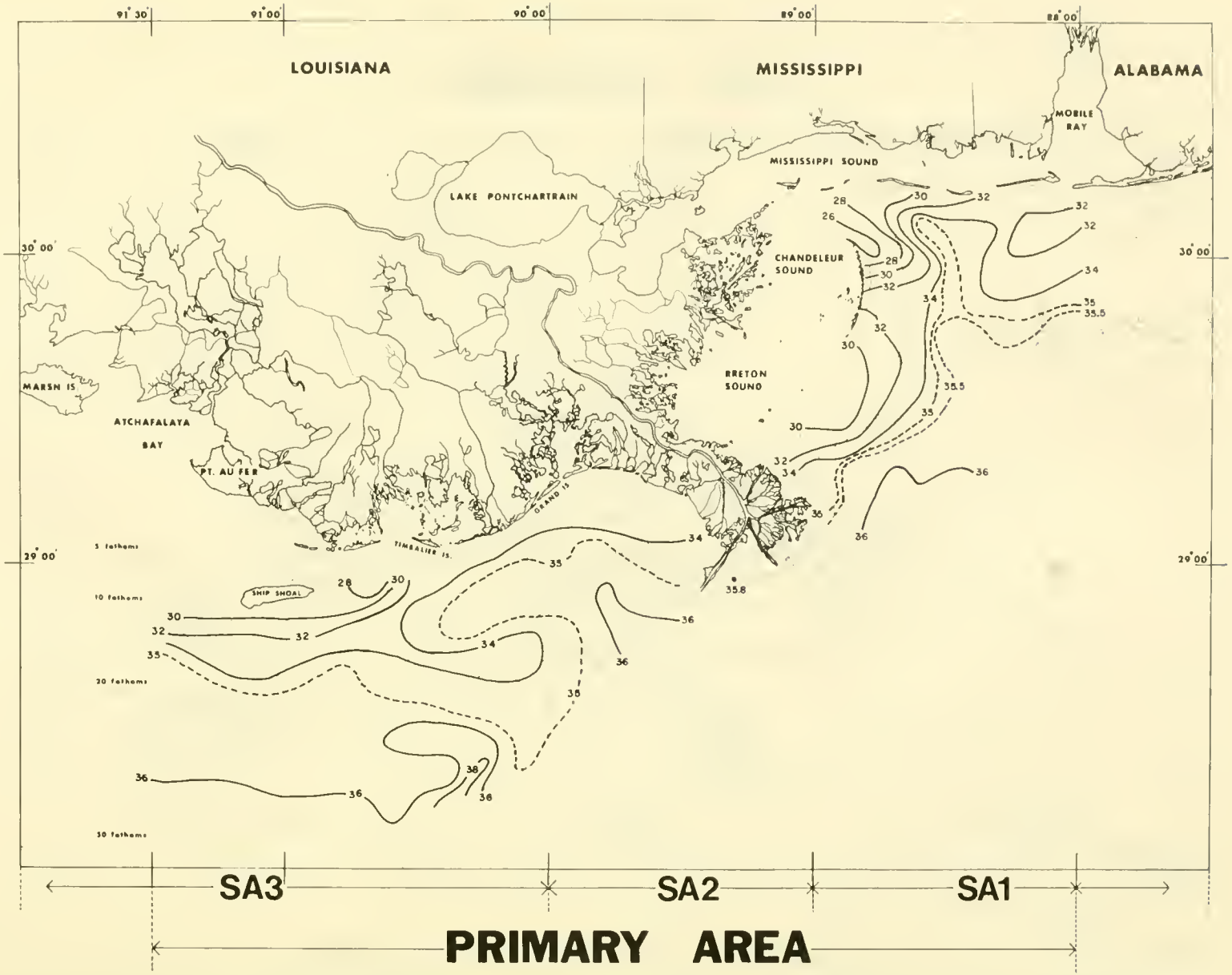

Figure 31.—Cruise 57, bottom salinity (ppt), March 1975.

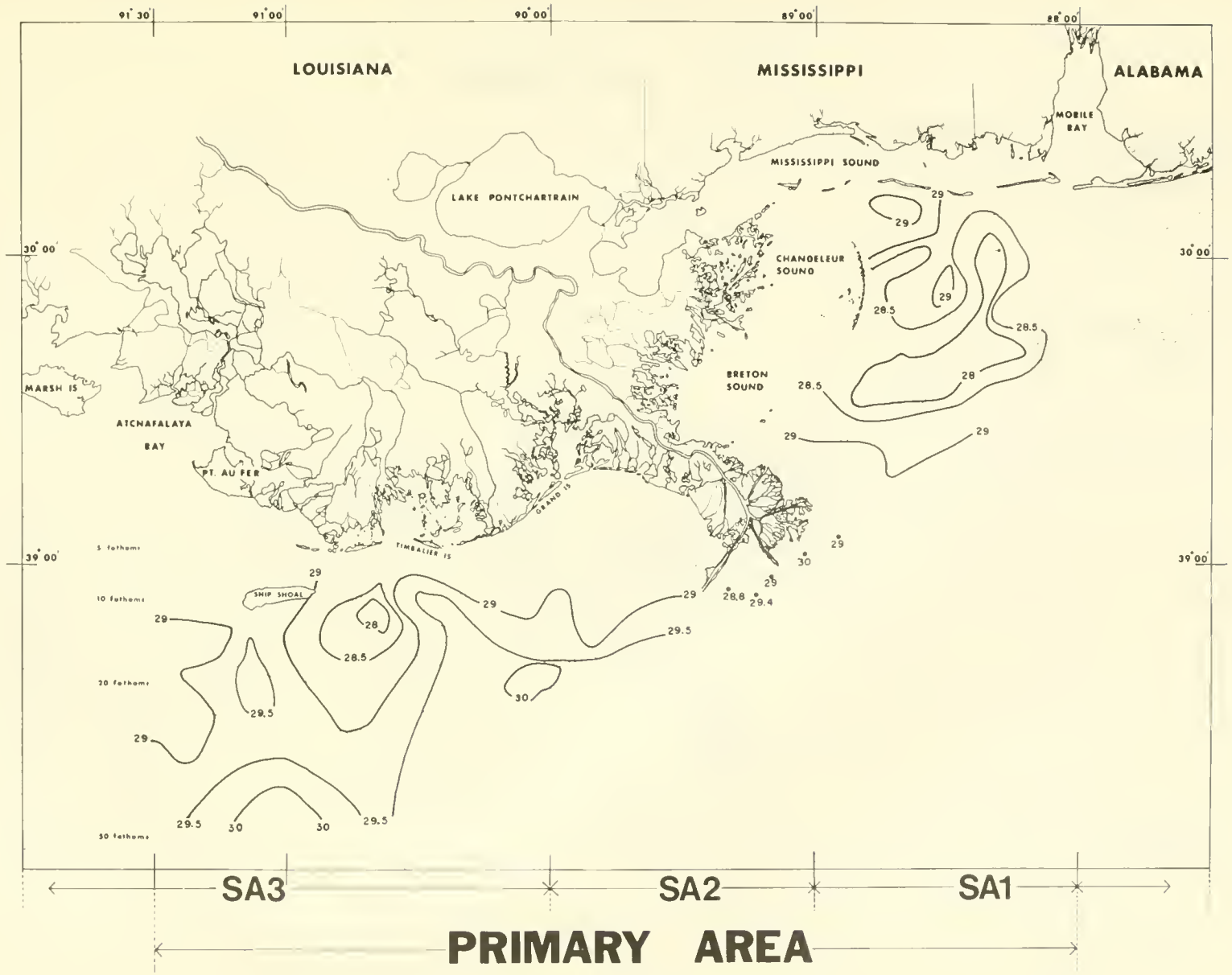

Figure 32.—Cruise 60, surface temperature (°C), July 1975.

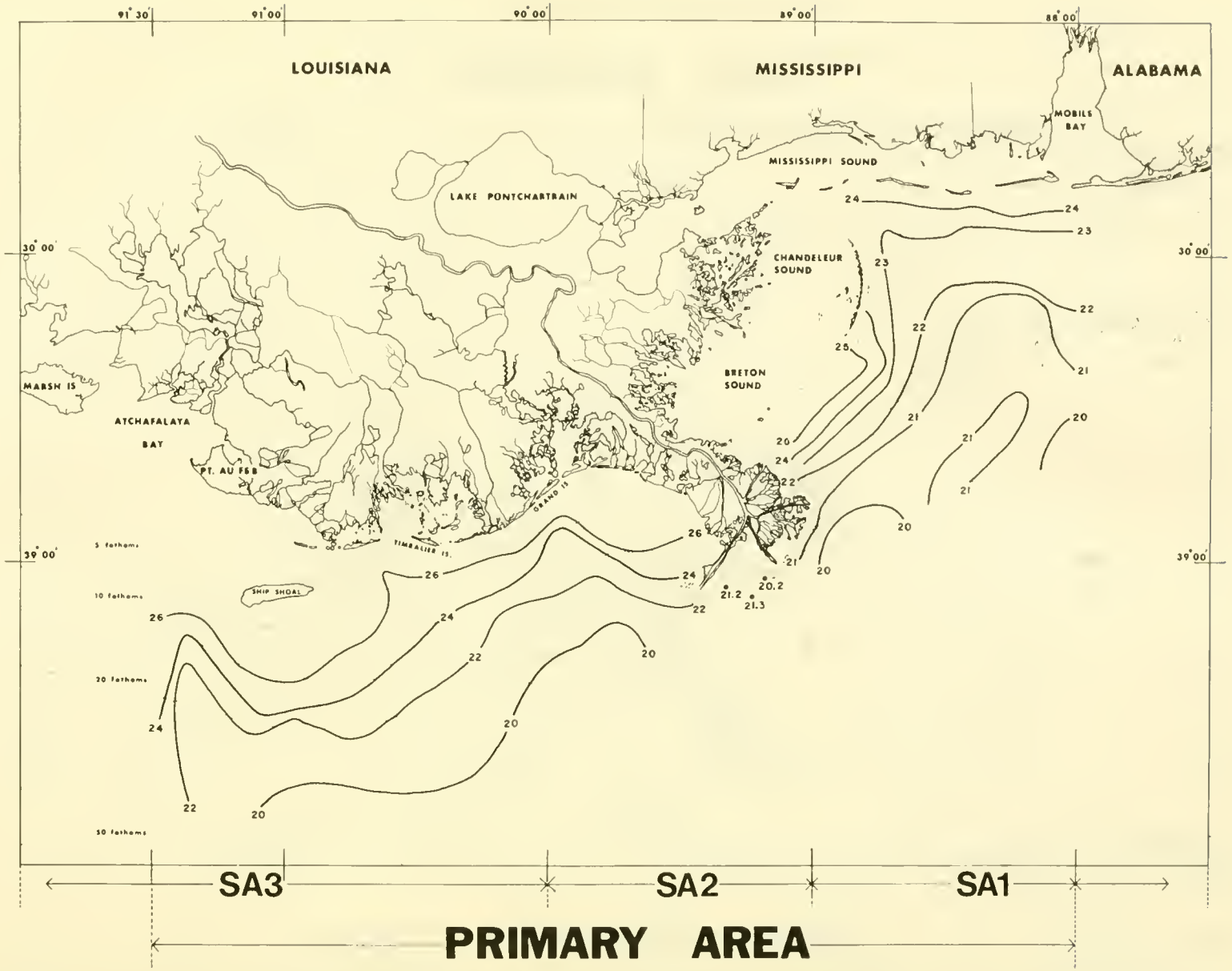

Figure 33.—Cruise 60, bottom temperature (°C), July 1975.

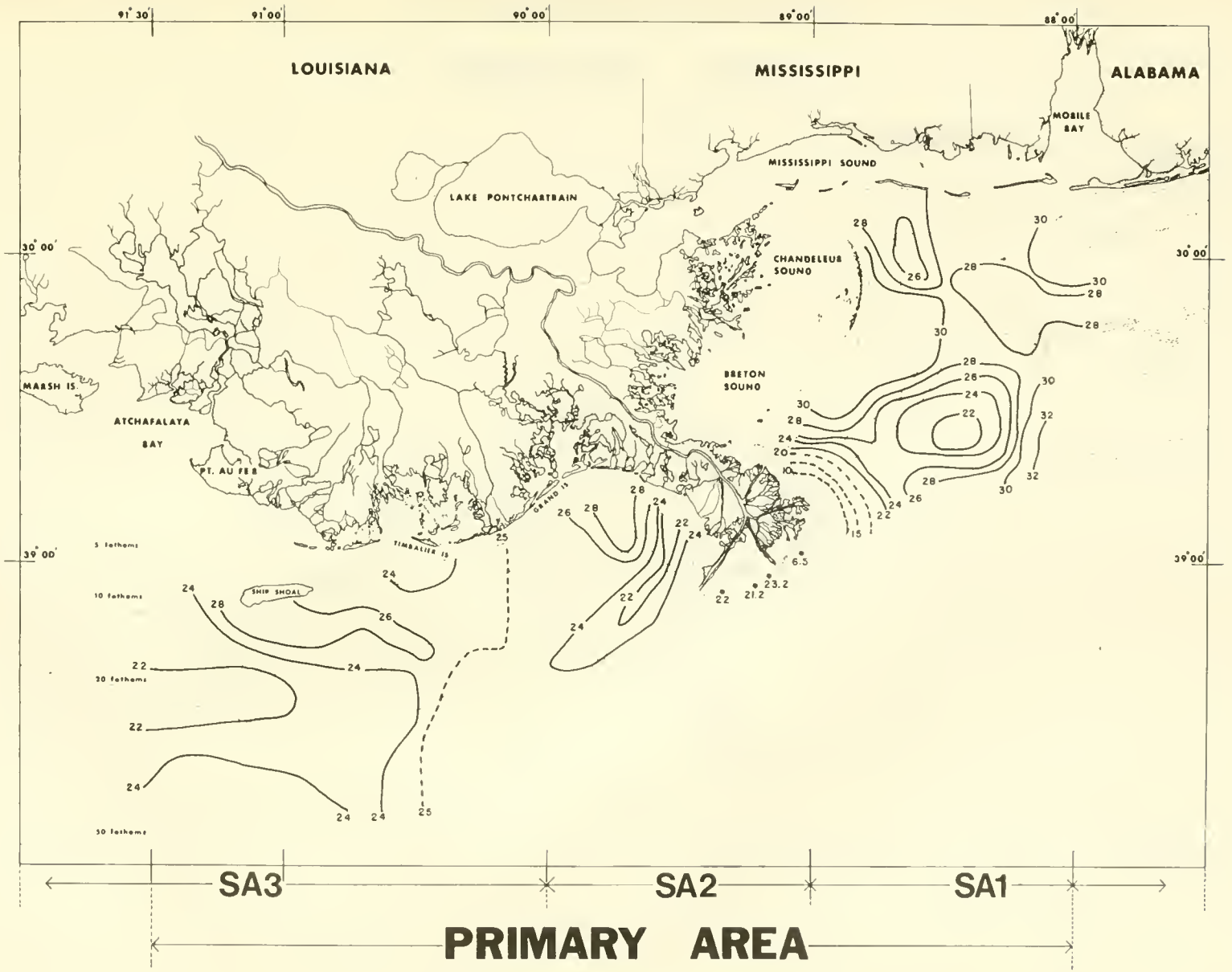

Figure 34.—Cruise 60, surface salinity (ppt), July 1975.

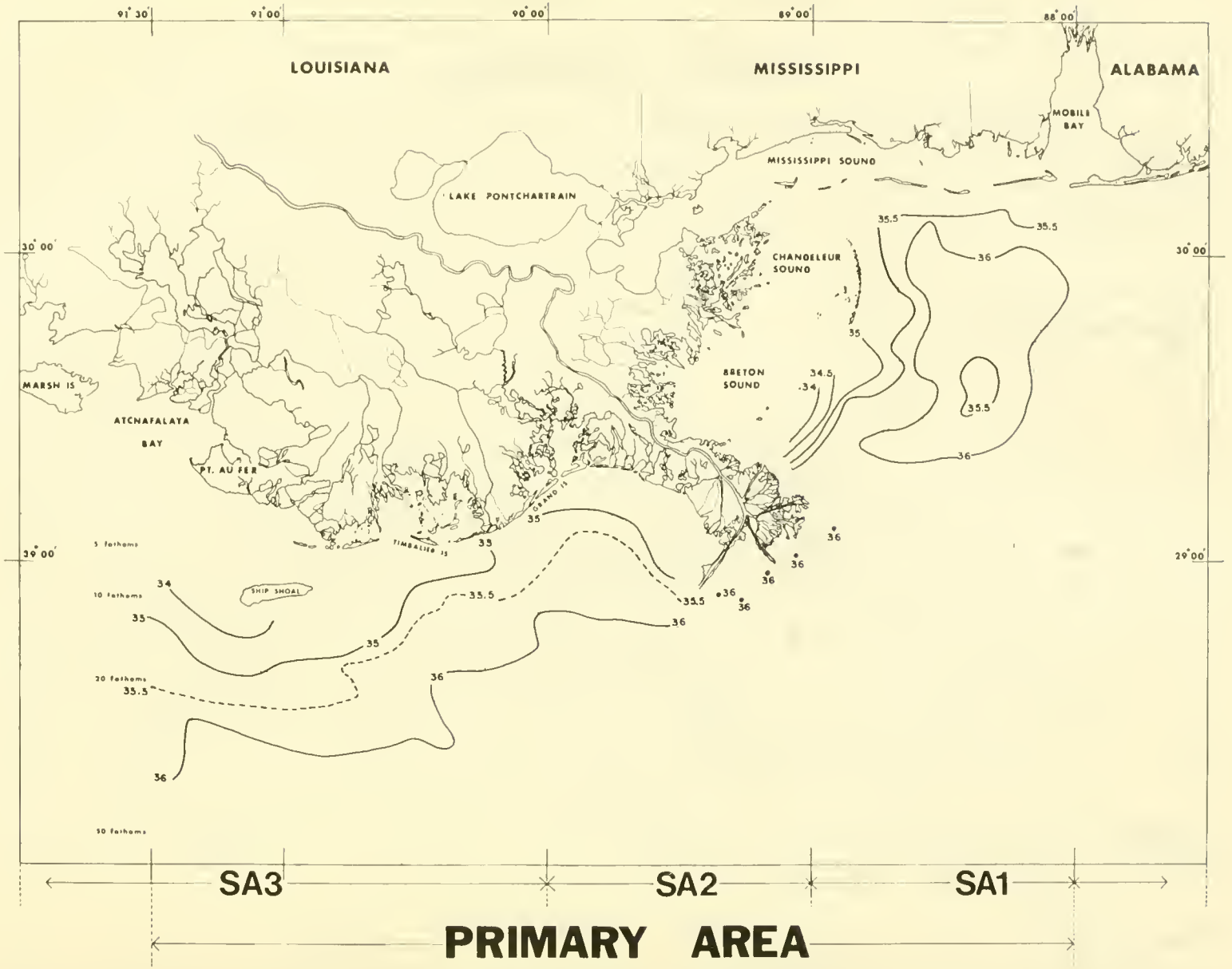

Figure 35.—Cruise 60, bottom salinity (ppt), July 1975.

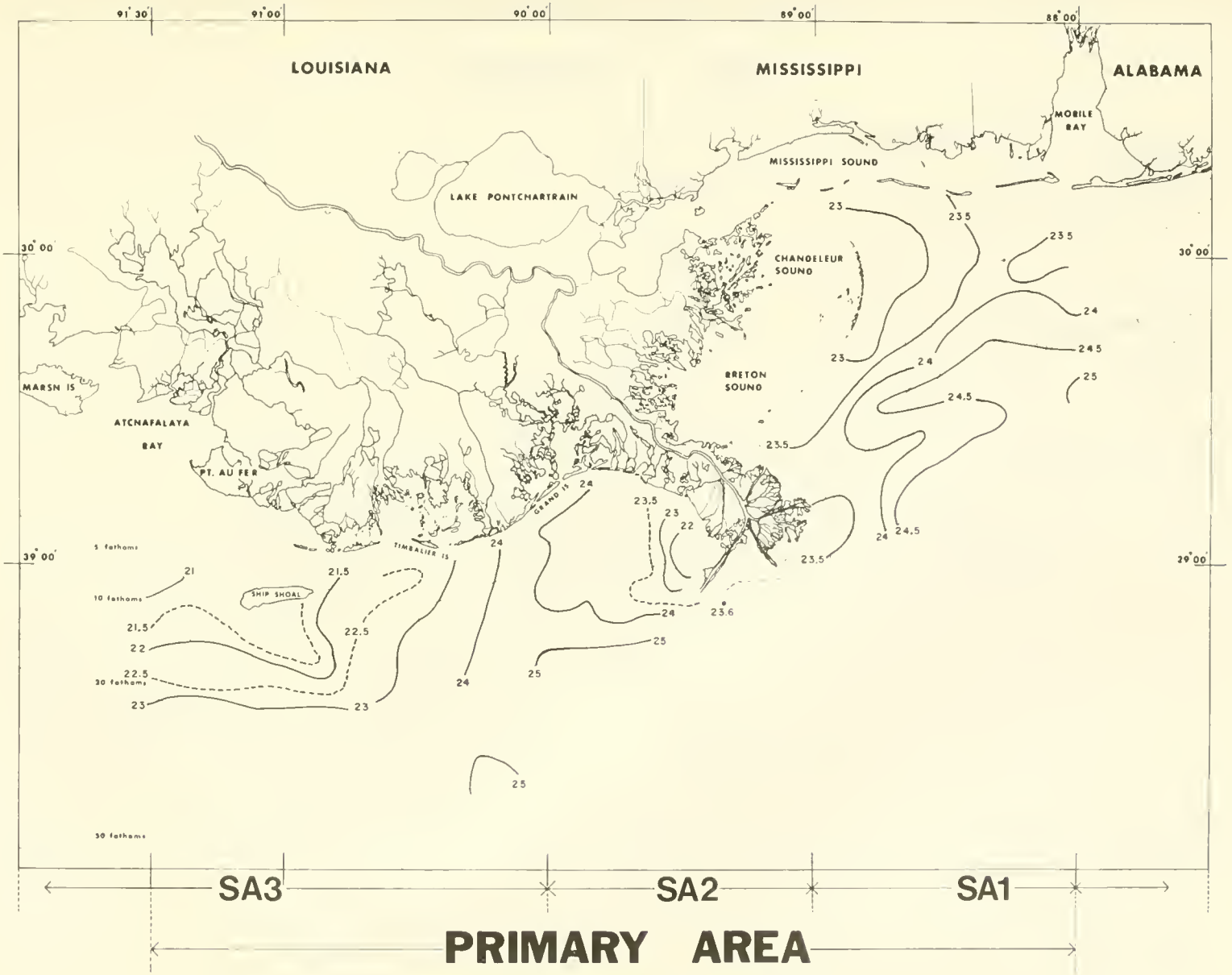

Figure 36.—Cruise 62, surface temperature (°C), November 1975.

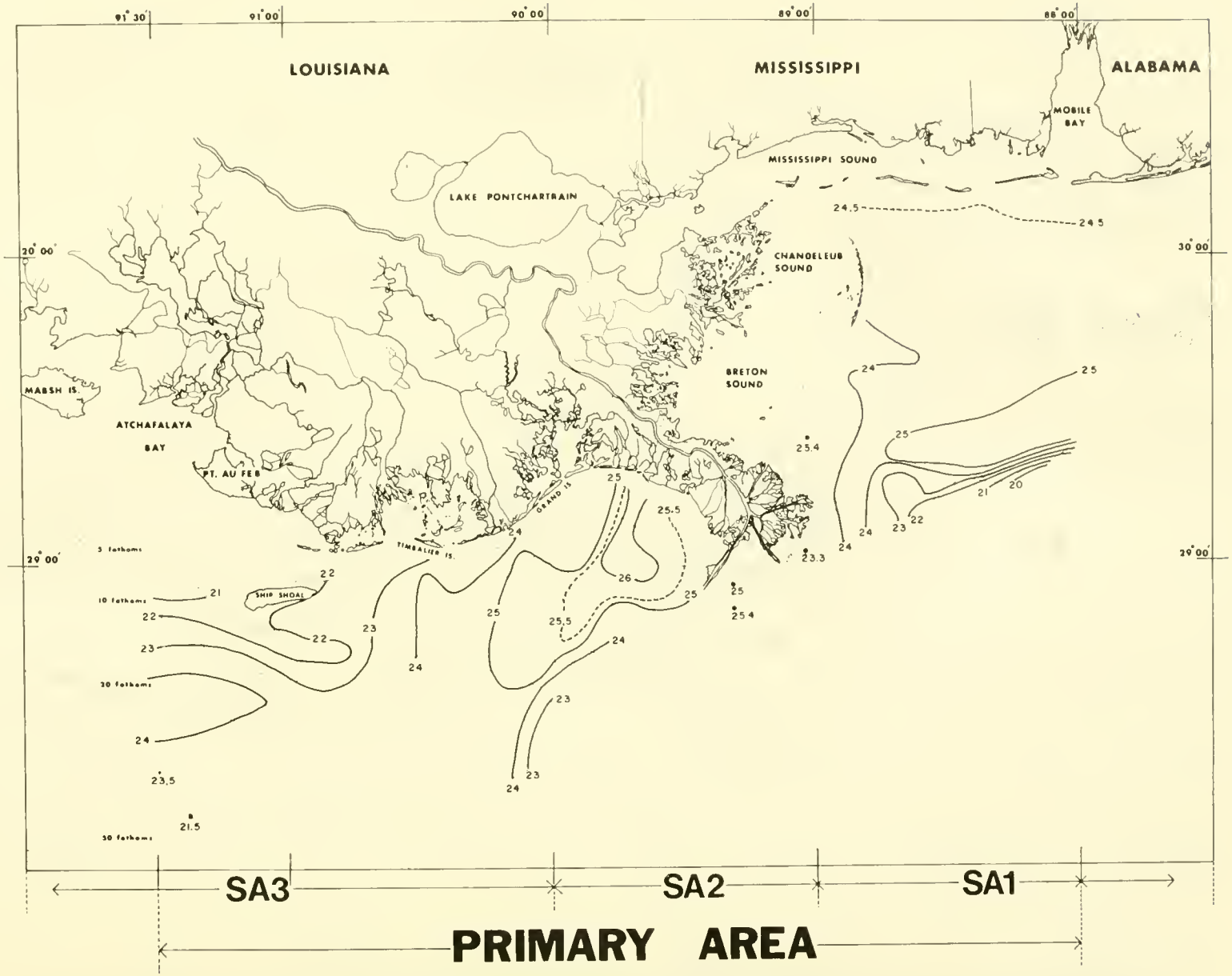

Figure 37.—Cruise 62, bottom temperature (°C), November 1975.

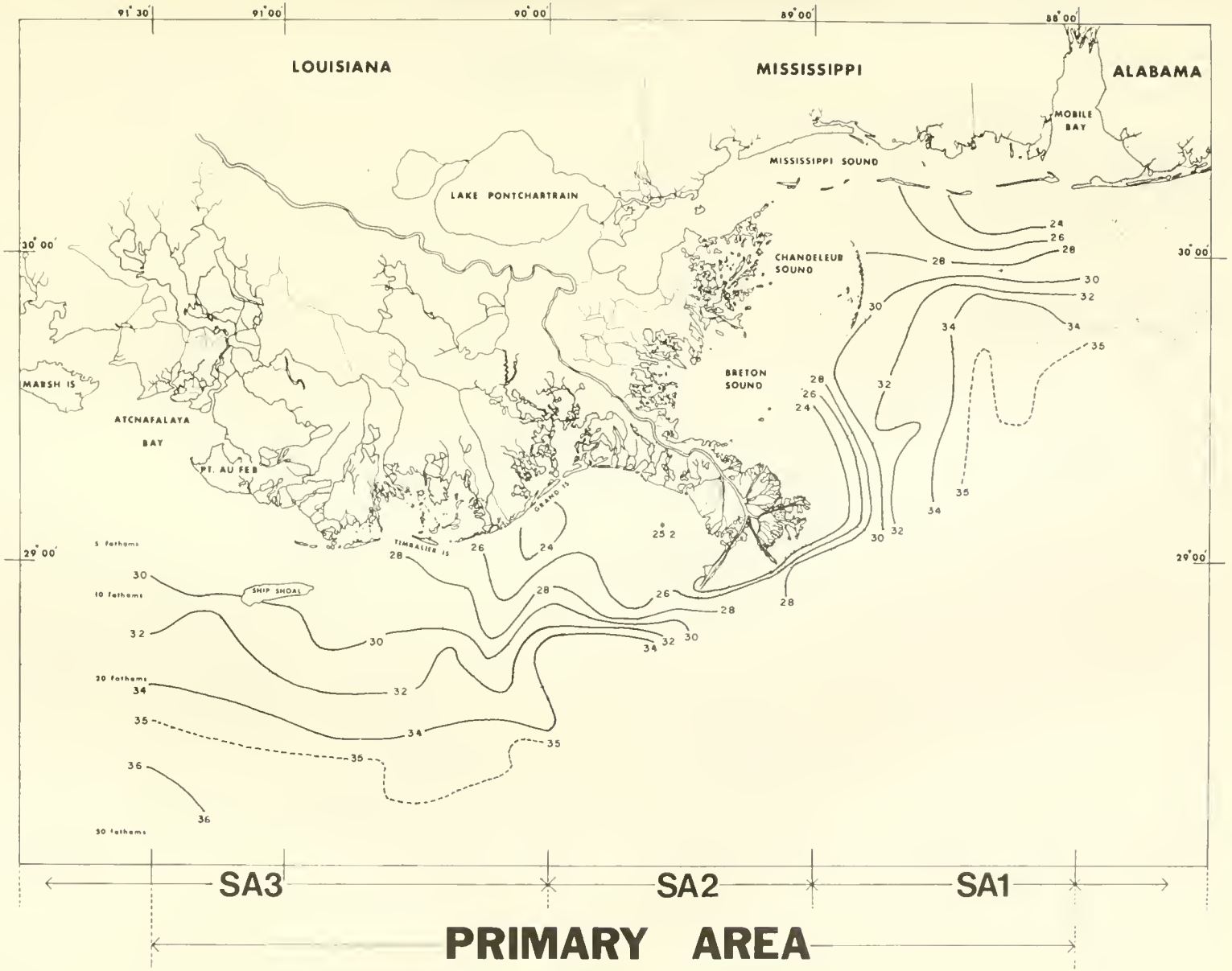

Figure 38.—Cruise 62, surface salinity (ppt), November 1975.

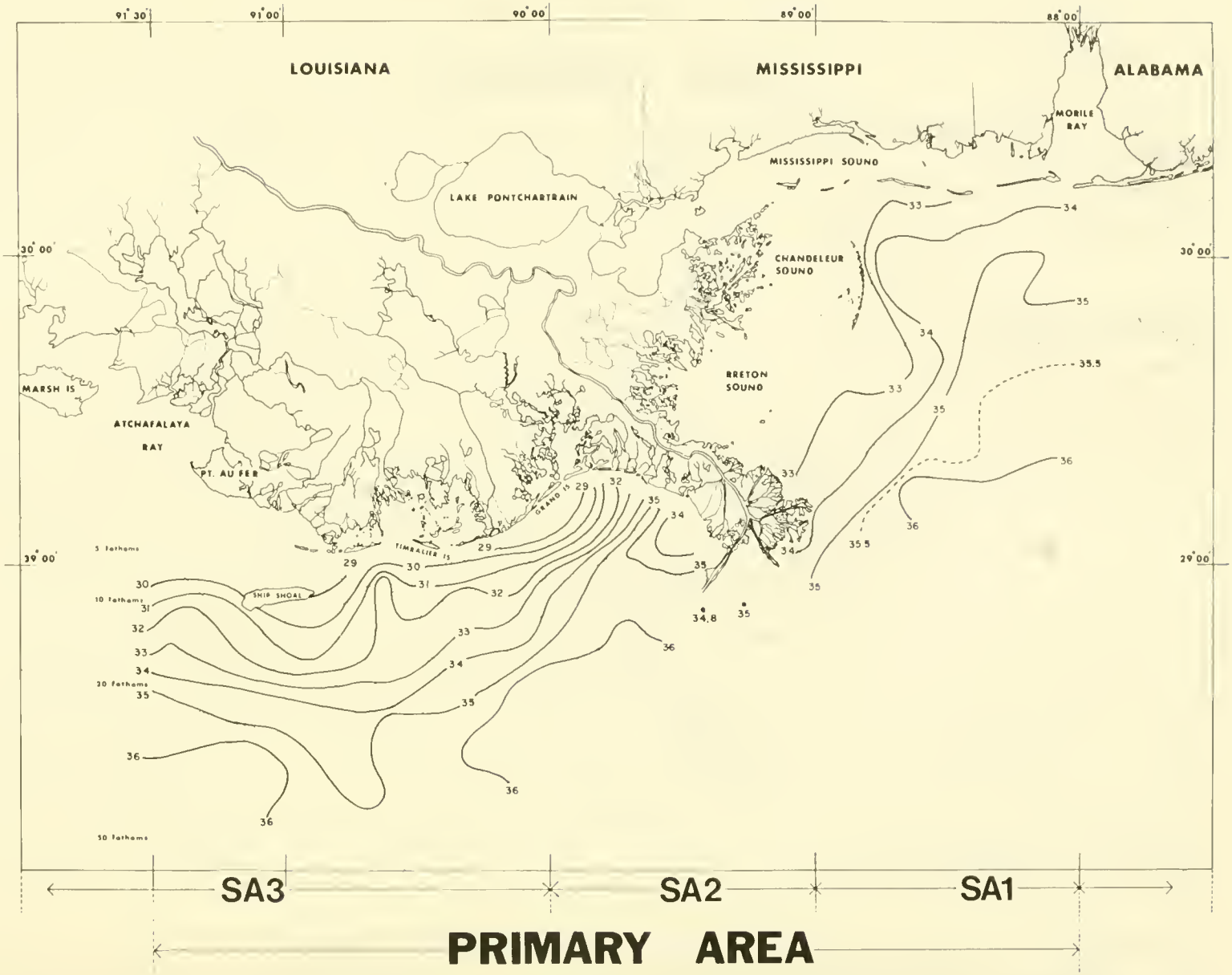

Figure 39.—Cruise 62, bottom salinity (ppt), November 1975.

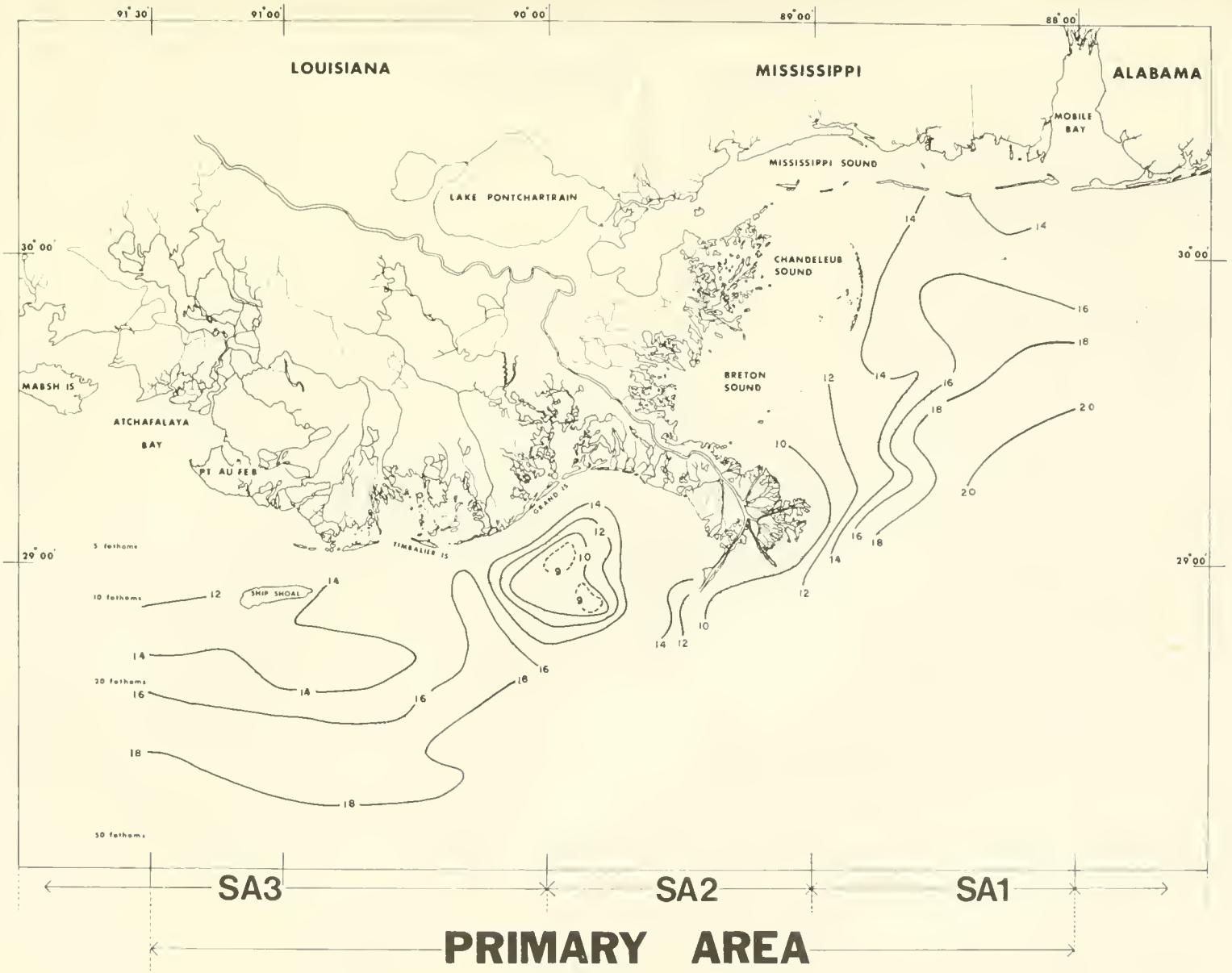

Figure 40.—Cruise 64, surface temperature (°C), January 1976.

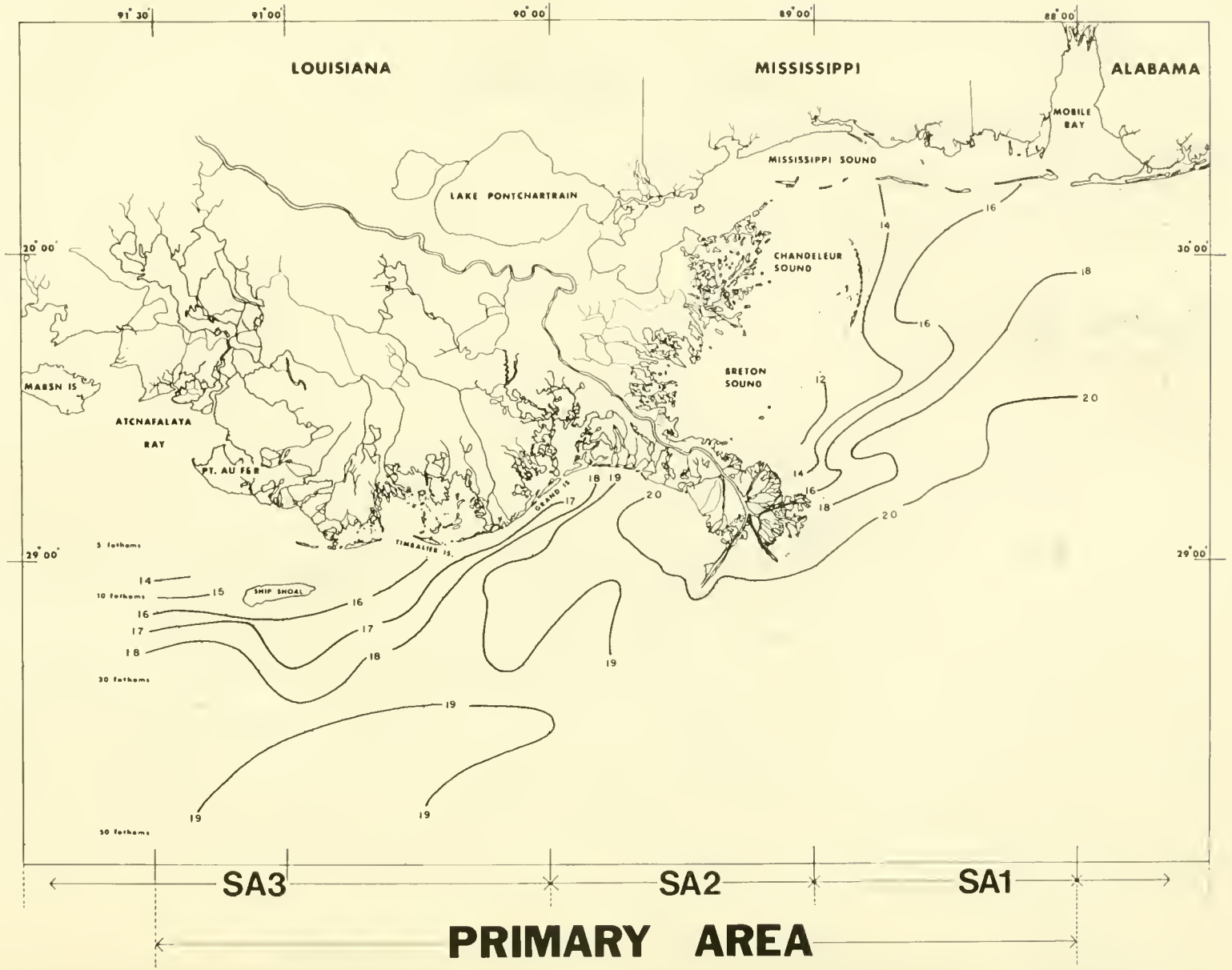

Figure 41.—Cruise 64, bottom temperature (°C), January 1976.

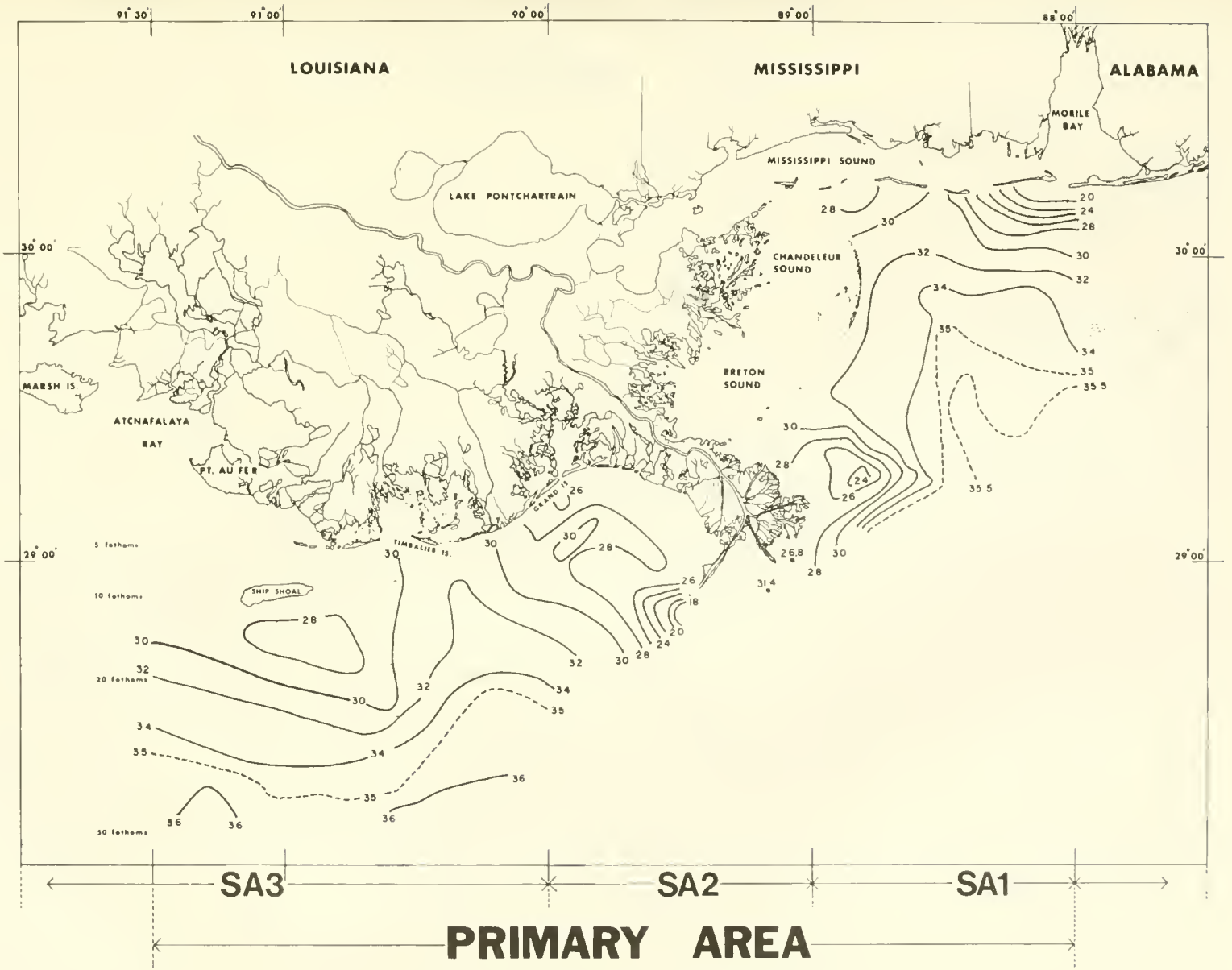

Figure 42.—Cruise 64, surface salinity (ppt), January 1976.

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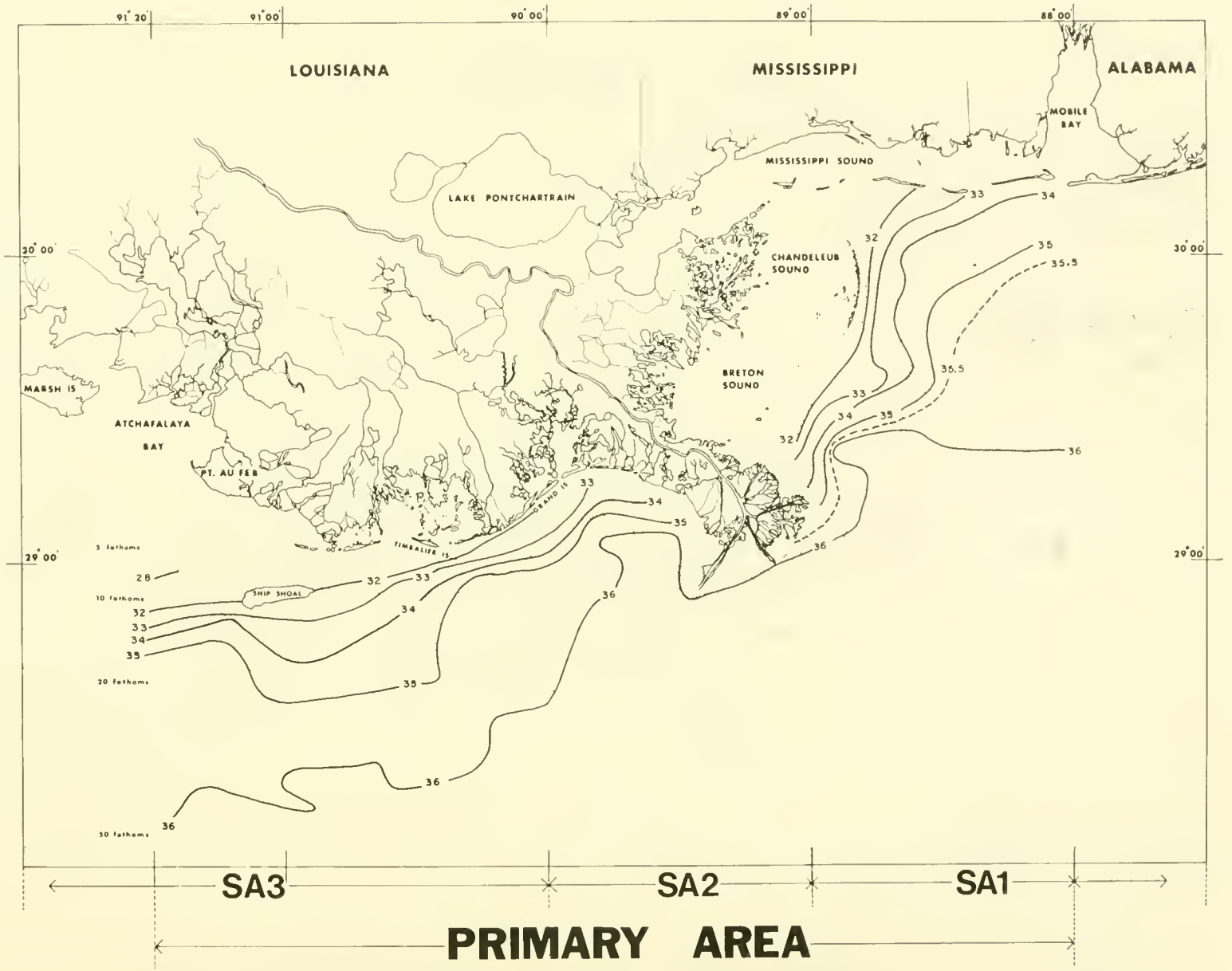

Figure 43.—Cruise 64, bottom salinity (ppt), January 1976.

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