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INFORMATION

Measurements of Currents in the Kane and Romanche Underwater Channels during Cruise 29 of the Research Vessel *Akademik Ioffe*

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The investigations of the flows in the abyssal channels of the Atlantic were continued during cruise 29 of the R/V *Akademik Ioffe*. Measurements were carried out in the Kane Gap (9°20′N, 19°50′W) and the Romanche Fracture Zone (0°27′N, 16°03′W). The measurements were carried out using an SBE-25 profiler with measurements of the currents by a Workhorse Sentinel lowered acoustic Doppler current profiler (LADCP). Three stations were occupied on the section across the Kane Gap, and four stations were occupied on the section across the Romanche Fracture Zone.

The Antarctic Bottom Water (AABW) with the potential temperature $\theta < 2$°C spreads from the Southern Ocean to the north through the western basins of the Atlantic. This water propagates from the West Atlantic to the eastern basins mainly through the fractures in the Mid-Atlantic Ridge: the Vema Fracture Zone (11°N) and the Romanche and Chain equatorial fractures (Fig. 1). The Antarctic Bottom Water flows to the Cabo Verde and Canary basins through the Vema Fracture Zone, while, to the Sierra Leone and Guinea basin, it flows through the Romanche and Chain fracture zones. The Kane Gap, in turn, is the deepest passage connecting the Cabo Verde and Sierra Leone basins. It is located between the Sierra Leone Rise and the Guinea Plateau near the African continent (Fig. 1). It is known that the bottom layer in this passage is occupied by the AABW with θ not lower than 1.85°C [1]. The water exchange (the structure of the currents) through this passage remains almost unstudied. The few attempts to obtain indirect estimates of the flow in the Kane Gap show that this flow is directed to the northeast (see [1]).

MEASUREMENTS IN THE KANE GAP

The properties of the abyssal waters in the Kane Gap were considered in [5]. In particular, it is reported that $\theta = 1.89$°C at the bottom of the main sill. The authors indicate that the thermohaline properties of the waters in the passage are more similar to the waters in the Cabo Verde Basin than to the waters of the Sierra Leone Basin and call the southeastern edge of the Cabo Verde Basis a cul-de-sac for the further propagation of the waters after they pass the Vema Fracture Zone.

The value of the potential temperature at the bottom $\theta = 1.857$°C was measured in May 2009 during cruise 27 of the R/V *Akademik Ioffe* at the main sill of the Kane Gap, which is close to the previously known values in the region of the passage. Direct measurements of the currents performed for the first time at this station showed that the flow of the AABW at the main sill of the passage is directed to the southeast, and its velocities are approximately 10 cm/s [2]. The corresponding water transport between two underwater slopes with a distance of 20 km between them was 0.16 Sv if we assume that the $\theta = 1.9$°C isotherm is the upper boundary of the flow.

Owing to the fact that, in May 2009, we obtained an interesting result when measuring the bottom water flow, on October 30, 2009, during cruise 29 of the R/V *Akademik Ioffe*, we again occupied a section across the Kane Gap consisting of three CTD-profiling stations with the current measurement using an LADCP Doppler profiler.

Unlike the measurements in May, the measurements in October demonstrated that the bottom water transport is directed to the north with maximum velocities of 10 cm/s and the total transport equal to 0.11 Sv if we assume that the $\theta = 1.9$°C isotherm is the upper boundary of the flow.

A record low temperature among all the measurements in this region at the bottom ($\theta = 1.846$°C) was recorded in the section in October 2009. The formation of the cold fresh core of the bottom water flow at the southwestern slope of the passage can likely be explained by the influence of the Ekman bottom friction similar to the displacement of the core in the

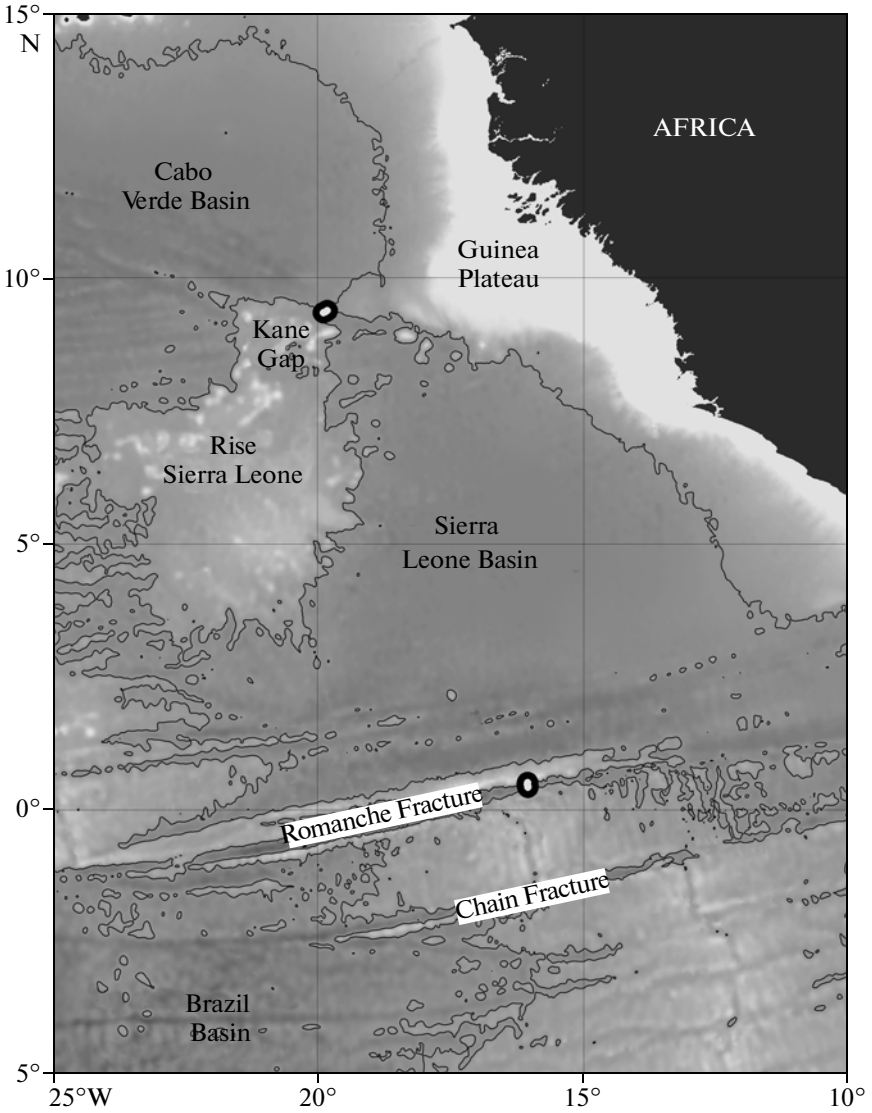

Fig. 1. Bottom topography of the ocean in the studied region. The circles denote the stations occupied during cruise 29 of the R/V *Akademik Ioffe*. The 4300 m isobath is also highlighted.

Vema Channel [3]. A displacement to the left slope in the direction of the flow is characteristic of the Northern Hemisphere. The distribution of the potential temperature over the section is shown in Fig. 2.

Such sufficient differences in the results of the measurements in May and October 2009 indicate that the bottom water flow in the Kane Gap changes its direction periodically. It is very likely that this is related to the seasonal variations in the water transport to the Guinea Basin by the currents in the Romanche and Chain fracture zones [4].

MEASUREMENTS IN THE ROMANCHE FRACTURE ZONE

The Romanche Fracture Zone, together with the Chain Fracture Zone, was intensely studied in 1991–1994 within the World Ocean Circulation Experiment (WOCE) program. The direct measurements of the currents using a series of current meters in the Romanche and Chain fracture zones presented in [4] showed that the easterly transports of the AABW in these fracture zones are comparable (the $\theta = 2°C$ isotherm was assumed as the upper boundary of the AABW): 0.66 ± 0.14 and 0.56 ± 0.17 Sv, respectively. Later, in 2005, an expedition of the Institute of Oceanology of the Russian Academy of Sciences onboard the R/V *Akademik Ioffe* performed a transect in the area of Western saddle of fracture Romani. In the 29th voyage of RV *Akademik Ioffe* on November 2009 occupied a section of four stations with CTD profiles and measurements of the currents using an LADCP profiler across the Romanche Fracture Zone in the region of the western sill (along the 16°03′W meridian). The sec-

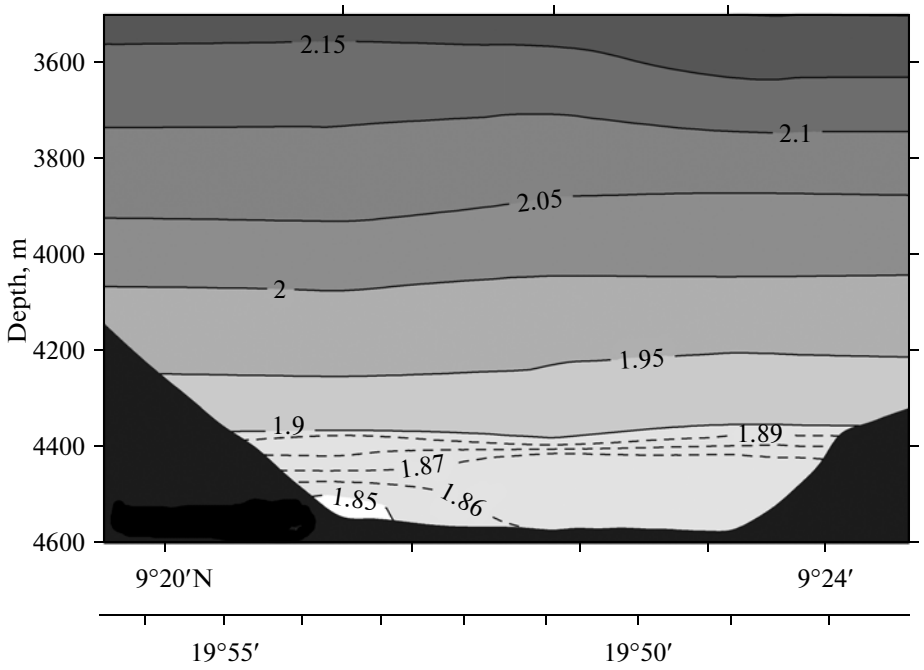

Fig. 2. Potential temperature (°C) during the section across the Kane Gap on October 30, 2009.

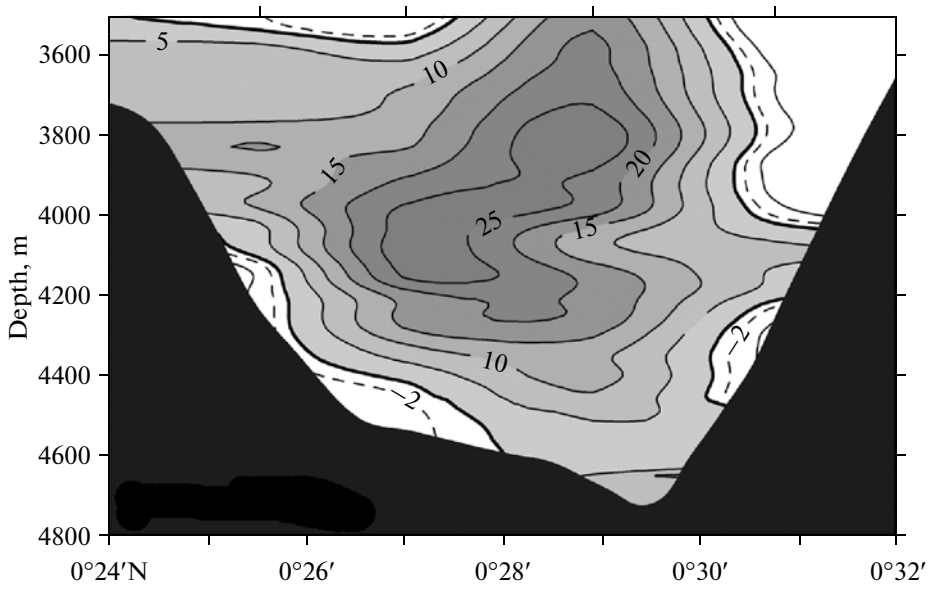

Fig. 3. Component of the currents normal to the section in the Romanche Fracture Zone measured using the LADCP instrument in November 2009.

tion passed along a local sill of the fracture and coincided with the series of measurements carried out in August 1991 (the Romanche 1 expedition) and with the section in 2005 mentioned above. The corresponding distribution of the velocity component normal to the section in 2009 is shown in Fig. 3.

The core of the current was found at a depth of approximately 4100 m with easterly velocities exceeding 25 cm/s (Fig. 3). The estimate of the AABW transport through the Romanche Fracture Zone is 0.9 Sv if the upper boundary is selected as the $\theta = 2°C$ isotherm (it approximately corresponds to the 3800 m isobath in the section). The corresponding transport in 2005 is estimated at 0.5 Sv. The maximum velocities in 2005 in the core of the current only slightly exceeded 10 cm/s.

During the period that passed between the Romanche 1 (1991) expeditions and our sections in 2005 and 2009, some variations in the thermohaline

characteristics of the bottom waters occurred, in particular, a gradual increase in the minimum potential temperature was recorded in the bottom layer from 0.695°C in 1991 to 0.730°C in 2005, and up to 0.752°C in 2009. The minimum salinities in the bottom layer almost did not change during this period.

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