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Abstract

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GEOPHYSICS

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INTENSITY OF THE GAMMA FIELD ABOVE THE WATER SURFACE OF THE SEA

(Presented by Academician E. N. Pavlovskii on 3 VII 1961)

In 1959–1960 observations were carried out of the intensity of the γ-field over the waters of the Barents Sea. Such observations are of interest in that the underlying surface in different regions is practically identical, the release of radioactive emanation into the atmosphere from such a surface must be the same everywhere, and the hard component of radiation from natural radioactive elements located in the ground, beginning at depths greater than 10 m, is completely screened by water. Consequently, it may be assumed that the intensity of the γ-field over the waters of the sea can vary appreciably depending not on the emanating capacity of the underlying surface, but on certain other factors. This assumption is quite plausible, since, according to the investigations of S. G. Kirdin and others, a characteristic feature of areas with a large water surface is the absence of local influx of emanation into the atmosphere (⁀4).

The influence of the emanating capacity of the coastal relief on the intensity of the γ-field over the sea was taken into account by dividing all the regions surveyed into three groups: 1) open-sea regions, 2) coastal regions, 3) regions directly adjacent to emanating rocks.

As open-sea regions, areas located 50–100 miles from the coastline were selected. The points of coastal observations were 2–6 miles from the shore and were situated in the coastal zone of Eastern and Western Murman, in the Kola and Motovsky Bays. Areas located in regions directly adjacent to emanating rocks were selected in various inlets and bays of the Barents Sea (Dal' ne-Zelenetskaya Bay, the Ara and Tyuva inlets, and the region of the Murmansk port).

Measurements of the intensity of the γ-field above the sea surface were made on a research vessel. A highly sensitive airborne geophysical station of the ASGM-25 type (⁀1,5) was installed on the vessel. The readings were recorded on an attachment constructed on the basis of the tape drive of an EPP-09 potentiometer. As the recording device, a galvanometer from the radiometric altimeter of the same station was used. This design made it possible to obtain slow recording

Fig. 1. Diurnal variations of the γ-field intensity at several stations.

Figure 1: Fig. 1. Diurnal variations of the γ-field intensity at several stations.

speeds, which considerably simplified and facilitated the processing of the results obtained.

The detector was the γ-detector of the station, consisting of 72 VS-9 counters arranged in two metal cassettes. The cassettes were fastened at a height of 11 m above the water level to rigging made of steel cable, secured between the masts (stay—carnac). This height was determined experimentally and adopted as the working height; it made it possible to eliminate the correction for shielding produced by the hull of the ship. Calibration ($^{3,}5$) of the station was carried out under the same conditions with the aid of vertically movable radium standards of various strengths, which are excellent γ-standards ($\hat{}2$). For this purpose each of the standards was successively placed at previously designated points. The dose rate of radiation produced was recorded on the tape of the radiograph attachment.

The high voltage supplied to the sensor counters was set in accordance with the selected operating point on a previously recorded plateau. On the basis of the mean values obtained from several recordings, a calibration curve was constructed. In the region of low dose rates of γ-radiation, the calibration curve was extrapolated, and for this section of the graph the natural γ-background was taken into account during calibration. In different calibrations carried out at sufficiently close time intervals at the same test site, the values of the γ-background agreed well.

Fig. 1. Diurnal variations of the γ-field intensity at several stations.

		H, m	φ λ
a	Ara Bay	28	69°22$’ 5|32°48’ 2|| ∗ ∗*b* ∗ ∗|*MurmanskPort*|9|68°57’ 3|33°08’ 0|| ∗ ∗*v* ∗ ∗|*DalnieZelentsy*|17|69°07’ 1|36°04’ 5|| ∗ ∗*g* ∗ ∗|*Centralpartofthesea*|160|70°44’ 0|35°45’ 0|| ∗ ∗*d* ∗ ∗|*Centralpartofthesea*|280|72°00’ 0|43°00’ $0

A total of 205 daily and underway stations were made. Most of the stations were underway, i.e., the γ-field intensity was recorded while the vessel was moving through the area being studied. Daily stations in coastal regions, in inlets, and in bays were tied to precisely determined coordinates. In the open sea these stations were confined to a square with an area of no more than 4 sq. miles. The γ-field intensity was assigned to the coordinates of the central point. Recording of γ-field intensity at daily stations was carried out continuously for 24 hours. The γ-field intensity values for some stations—averages of several values obtained in the same areas at different times—are given in Table 1. Variations of γ-field intensity at several daily stations are shown as a graph in Fig. 1.

Table 1

γ-field intensity in some regions of the Barents Sea during VII 1959–VII 1960 (underway stations)

Open-sea regions				Coastal regions				Regions in inlets, bays, and gulfs			
Station Nos.	φ	λ	P_γ	Station Nos.	φ	λ	P_γ	Station Nos.	φ	λ	P_γ

Open-sea re-gions	Coastal re-gions	Regions in in-lets, bays, and gulfs
B-1	69°06$’ 2.9	
	6|37°36’	
	0|2.5|*A*—	
	1|69°14’	
	0|35°50’	
	0|2.5||||||*B*—	
	3|70°15’	
	0|41°20’	
	0|2.9|*A*—	
	2|69°19’	
	2|35°16’	
	0|2.4|*C*—	
	1|69°24’	
	0|32°48’	
	2|3.1||3120|72°40’	
	0|43°00’	
	0|2.7|*A*—	
	3|69°31’	
	3|34°06’	
	0|2.2|*C*—	
	2|69°26’	
	15|32°52’	
	8|3.0||351|70°49’	
	0|39°05’	
	0|2.6|*A*—	
	4|69°27’	
	0|33°27’	
	3|2.2|276|69°14’	
	63|33°35’	
	69|4.3||343|71°50’	
	0|39°05’	
	0|2.6|*A*—	
	5|69°40’	
	3|36°03’	
	5|2.5|275|69°14’	
	95|33°34’	
	27|3.0||*B*—	
	7|72°22’	
	5|37°20’	
	0|2.7|*A*—	
	6|69°25’	
	0|34°38’	
	0|2.3|4|68°56’	
	96|33°00’	
	90|3.0||*B*—	
	8|71°00’	
	0|35°18’	
	0|2.3|*A*—	
	7|69°26’	

From the table and the graph it is evident that, as one moves deeper into the bays and inlets, an increase in γ-field intensity is observed, since the γ-field intensity near the shore depends on the relief of the terrain and on the emanating capacity –

properties of the surrounding rocks. The γ-field above the water surface in regions located far from large industrial facilities is always smaller than in similar regions adjacent to industrial facilities. The γ-field in open-sea regions is in most cases somewhat lower than in coastal regions.

Of the five daily stations shown on the graph, the greatest γ-field intensity was recorded at the head of Ara Bay. At the two sea stations a comparatively low γ-field intensity was found; the agreement of the results for these stations is good.

The results of repeated measurements at both transit and daily stations show that the intensity of the γ-field above the water surface is a relatively constant quantity. A similar constancy has also been noted by some authors for the intensity of the γ-field above the surface of the Earth ([4], [7]).

An increase in the intensity of the γ-field above the water surface is observed during precipitation, especially rain. This may probably be associated with the natural radioactivity of falling raindrops. It is known that the natural radioactivity of raindrops is measured in quantities on the order of 10^{-11} curie/g ([7]). Falling onto the surface of the Earth, rain may form a radioactive layer responsible for an increase in the intensity of the γ-field in the adjacent air layer. Obviously, after rainfall a similar layer may also be observed on the sea surface. Some time after the precipitation ceases, the intensity of the γ-field decreases to normal, which is apparently connected with mixing of the upper freshened layer, containing an increased amount of natural radioactive isotopes, with the underlying mass of seawater.

From the hygienic point of view, the external radiation dose received by a person under marine conditions fits within modern conceptions of the permissible limits of external γ-irradiation from natural radiation. In absolute magnitude it is smaller than under coastal conditions ([6], [8]).

The values of the γ-field intensity above the sea area given in the figure and in the table may serve as initial values for subsequent observations in these same regions.

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Note: Figure translations are in progress. See original paper for figures.