REGIONAL AND LOCAL COASTAL EFFECT IN GEOMAGNETIC VARIATIONS ON THE ISLAND ARCS OF THE FAR EAST

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Fig. 1

Figure 1: Fig. 1

Abstract

Full Text

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REGIONAL AND LOCAL COASTAL EFFECT IN GEOMAGNETIC VARIATIONS ON THE ISLAND ARCS OF THE FAR EAST

(Presented by Academician M. A. Sadovskii, December 29, 1966)

As is known, at middle latitudes, far from the polar and equatorial currents, the horizontal components of bay-like geomagnetic disturbances vary very smoothly along the Earth' s surface. At the same time, significant changes in the intensity of the vertical component are often observed over short distances, of the order of tens of kilometers.

Fig. 1

There are data on a change in the sign of this component between observation points located on different sides of a sharp geoelectrical inhomogeneity (*1*).

Since the maximum differences in electrical conductivity are observed at the boundary between well-conducting seawater and land, a change in the sign of the vertical component has most often been noted on opposite shores of islands or straits (*2*). However, it is easy to show that the "classical" coastal effect will be observed only in the case of an isolated island, around which the sea depth changes only slightly. If, however, there is a sharp subsidence nearby, then the regional anomaly of variations of the vertical component created by it may obscure the local coastal effect on the island. Indeed, consider the schematic section shown in Fig. 1. Let us have a narrow, elongated island and, at some distance from it, a step beyond which the depth increases and remains constant.

A horizontally polarized plane electromagnetic wave, which at middle latitudes is an admissible model of the exciting field, induces electric currents in the water. Since geomagnetic anomalies are produced by currents parallel to the shoreline, we shall consider only this polarization. Let us make two further assumptions. We shall neglect the influence of the electrical conductivity of the upper mantle, assuming that most of the currents, at oscillation periods of 0.5 hour–1 hour, are

Fig. 2

Figure 2: Fig. 2

Fig. 3

Figure 3: Fig. 3

concentrated in the water, and that relatively weak currents in the heated upper mantle (i.e., at depths of the order of 100 km) do not create sharp anomalies over a small area of the Earth' s surface (*3*). Secondly, we shall neglect the skin effect-

that. This assumption is valid when calculating the geomagnetic field near a small island whose dimensions are considerably less than the length of the electromagnetic wave in the medium, and also when estimating the anomaly produced by a scarp at points near it (4).

With the assumptions made, the amplitude of the variations of the vertical component of the geomagnetic field δZ can be found from the Biot–Savart law. The results of the calculation for the section shown in Fig. 1 indicate that disturbances of the vertical component at points located on opposite shores of the island have the same sign and differ by no more than 25%. Thus, a change of sign of δZ on opposite shores of an elongated island should not be observed in cases analogous to the one considered. It is masked by the regional anomaly due to the scarp.

For experimental confirmation of these ideas, in the summer of 1966 the Sakhalin Complex Scientific Research Institute of the Siberian Branch of the USSR Academy of Sciences carried out observations of geomagnetic disturbances on Iturup Island (Kuril Islands) (see Fig. 2). Fig. 3 presents copies of typical magnetograms obtained on 9 VII 1966 on the southeastern (the settlement of Burevestnik) and northwestern (the settlement of Kurilsk) shores of Iturup Island. As can be seen, the changes in the magnetic field are practically synchronous, while the intensity on the western shore is approximately 20% smaller.

Fig. 2

Fig. 3

The experiment carried out confirms the theoretical estimates and indicates two types of coast effect: regional and local. For island arcs separating the ocean from less deep inland seas, a predominance of the regional effect, caused by the oceanic scarp, over the local effect, due to the presence of the island, should be characteristic.

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