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MANIFESTATIONS OF LITHOSPHERIC STRUCTURES OF THE ANTARCTIC IN SATELLITE DATA

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Abstract. In 1979 from the data obtained by the "Intercosmos-19" satellite the effect of sharp increase of the low frequency electromagnetic emissions intensity in the upper ionosphere at the time of satellite passage over zones of an impending or going on earthquake was discovered. Combined processing of the low frequency emissions data, electron fluxes and plasma temperature, measured by the satellite in the northern hemisphere (20 orbits) has allowed us to reveal a previously unknown effect of low-frequency emission excitation and variation of electron flux above the deep faults in the earth's crust. In the aggregate, the results of these studies allow one to believe that the ionosphere and the processes going inside it can be considered as indicators of quick (earthquakes) and slow geo-dynamic processes occurring in the lithosphere.
In this paper satellite measurements of low (E_e~50 eV) and high energy (E_e≥ 40 keV, E_e≥ 100 keV) electron fluxes are analyzed for the southern hemisphere above the lithosphere faults in the Antarctic on June 14, 1979.

Introduction

When passing above various tectonic structures, differing in their physical characteristics and activity, over the faults of the South-Barents depression /1,2/, the "Intercosmos-19" discovered the simultaneous appearance of anomalous bursts of low frequency (0.1-20 kHz) noise emissions and low energy electron fluxes (50-120 eV) at the satellite altitudes. The correlation analysis showed that the observed low frequency emission bursts had electromagnetic nature. The correlation coefficient for the simultaneous intensity bursts of the magnetic and electric field components of the emission in the considered region was about 0.81 - 0.98.
In the present paper satellite measurements acquired in the southern hemisphere above the Antarctic (on June 14, 1979, orbit 1539) are studied for the first time. The geophysical activity for the orbit chosen was moderately quiet. The satellite orbit projection onto the earth's surface (Fig.1) crosses the southern margin of the underwater Kergelen plateau in the southern part of the Indian Ocean, the Davis Sea and enters the Antarctic region, adjacent the Australian-Antarctic Basin, near the Mirny and Pionerskaya stations. A considerable part of the orbit passes over the Antarctic ice shield, the thickness of which varies from 1.0 - 1.5 km in the Queen Mary Coast to 3.5 - 4.0 km in the Wilkes land. In the latter region the glacial bed apparently lies about 0.5 – 1.0 km below the sea level.

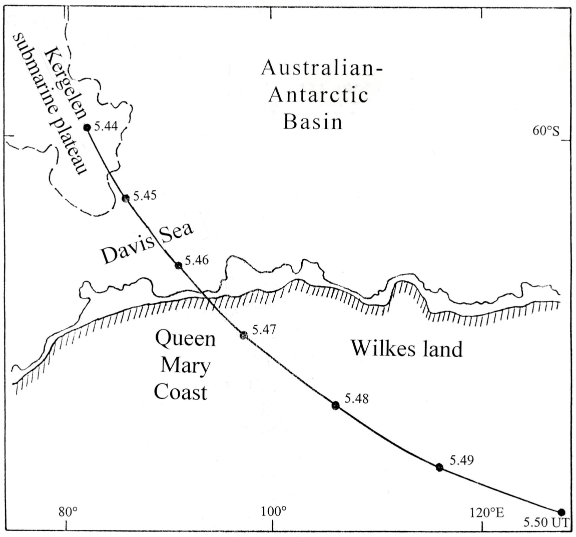

Fig. 1 The orbit projection of "Intercosmos-19" satellite on the Antarctic region for June 14, 1979 (orbit 1539).
Symbols: The solid line is the coastline defined by the edge of shelf glaciers and bedrock projections; The hatched solid line is the coastline formed by continental bedrock.

Considerable sea depth variations are typical for the sea part of the satellite orbit projection which are due to the structural peculiarities of the earth's crust.

Basic tectonic structures

A relatively small amount of tectonic data available /3 - 5/ allows us to reveal only a number of basic structural zones of the earth's crust, above which the satellite passed (Fig.2).
The Kergelen high (zone 1) is the earth's crust raise, formed originally by the Baikal (Late Proterozoic) and Paleozoic complexes. According to another hypothesis, this high was formed by a subocean crust raising of the Mesozoic-Cenozoic age.
The southern margin of the Kergelen high is confined by a deep system of marginal throwdowns and wrench faults (zone 2) that separates this high from the

graben-rift of the Davis Sea (zone 3). The graben-rift earth's crust, most likely, is presented by its subocean or ocean type variety, in which magma rocks predominate.
The southern flank of the graben-rift is formed by a combination of large systems of deep throwdowns and wrench faults (zone 4) or shore faults (zone 6) and tectonic steps, forming raised or lowered shelf plateaus (zone 5).
Further, the satellite orbit projection onto the Earth crosses the Queen Mary Coast high (zone 7) manifested in the subglacier relief and confined by a system of suture faults (zone 8). Then, the satellite orbit passes over the Wilkes land depression area (zone 9), which corresponds to the development of the PreCambrian (Pre-Baikalian) complexes of the basement. A more detailed division of this area into structural zones is hampered by an acute shortage of data on glacier bed structure.

Experimental data

The analysis of the experimental data showed that VLF-emission intensity variations over deep faults in the Antarctic lithosphere are similar to those observed over the Barents and Kara Sea faults in the northern polar region /1, 2, 6-8/. So, we will not consider them here.
Bursts of the electron flux with various energies: E_e~ 50 eV, $E_e \geq$ 40 keV, $E_e \geq$ 100 keV, as well as the ambient plasma temperature were registered onboard the satellite. A significant correlation between bursts of the electron fluxes and structural zones of the lithosphere was found along the satellite orbit both at the signal background level and at some local disturbances level. When the satellite passes over deep faults of the lithosphere, variations of the high- and low-energy fluxes are observed. The electron flux with energies $E_e \geq$ 40 keV undergoes a stepwise decrease along the satellite orbit when it moves above tectonic zones (1-7) from the auroral zone towards the Polar cap. Moreover, the maximum flux reduction gradients are bound to the location of the deep faults systems or are somewhat displaced relative to them.
The high energy flux ($E_e \geq$ 100 keV) variations are smaller than variations of the medium energy flux with $E_e \geq$ 40 keV. The maximum flux values are observed in the auroral zone in the area of the Kergelen high. Much lower flux values are typical for the region of the Queen Mary Coast high and the Antarctic shelf.
As for the low energy flux (E_e~ 50 eV), considerable variations of its value are observed over the faults systems, bordering the graben-rift (zones 2 and 5), and above the Queen Mary Coast high (zone 6). Smaller variations are evident above the Davis Sea graben-rift zone (zone 3). A distinct flux variation over the faults systems should be noted. The flux variations observed over the Davis Sea graben-rift zone may be associated with some features of the inner structure of this graben-rift that are, unfortunately, unknown to us so far.
Bursts of the high and low energy electrons that occurred at about 5.47 UT are associated with the satellite passage through the Polar cusp region but not with lithosphere faults. Then since 5.48 UT till 5.51 UT the satellite moved above the Polar cap, where small electron flux values were observed.
Variations of plasma temperature at the satellite altitude are observed over deep faults of the Antarctic shelf (zones 4, 5, 6), over the system of marginal throwdowns and wrench faults of the Kergelen high (zone 2), and over the Queen Mary Coast high (zone 7). A prominent temperature burst was observed at about 5.48.30 UT over the thick ice Antarctic shield. It may correspond to some large unknown structure irregularity in the earth's crust.

Conclusions

The following conclusions can be drawn from the data analysis:
1. The tectonic contours of the structural elements represented by lithosphere faults manifest themselves both in the peculiarities of the VLF emission variations and in bursts of electrons of different energies.
2. The correlation between the bursts of electrons and the earth's crust peculiarities manifests in their spatial coincidence and in the change of the electron fluxes above zones with different tectonic structures.

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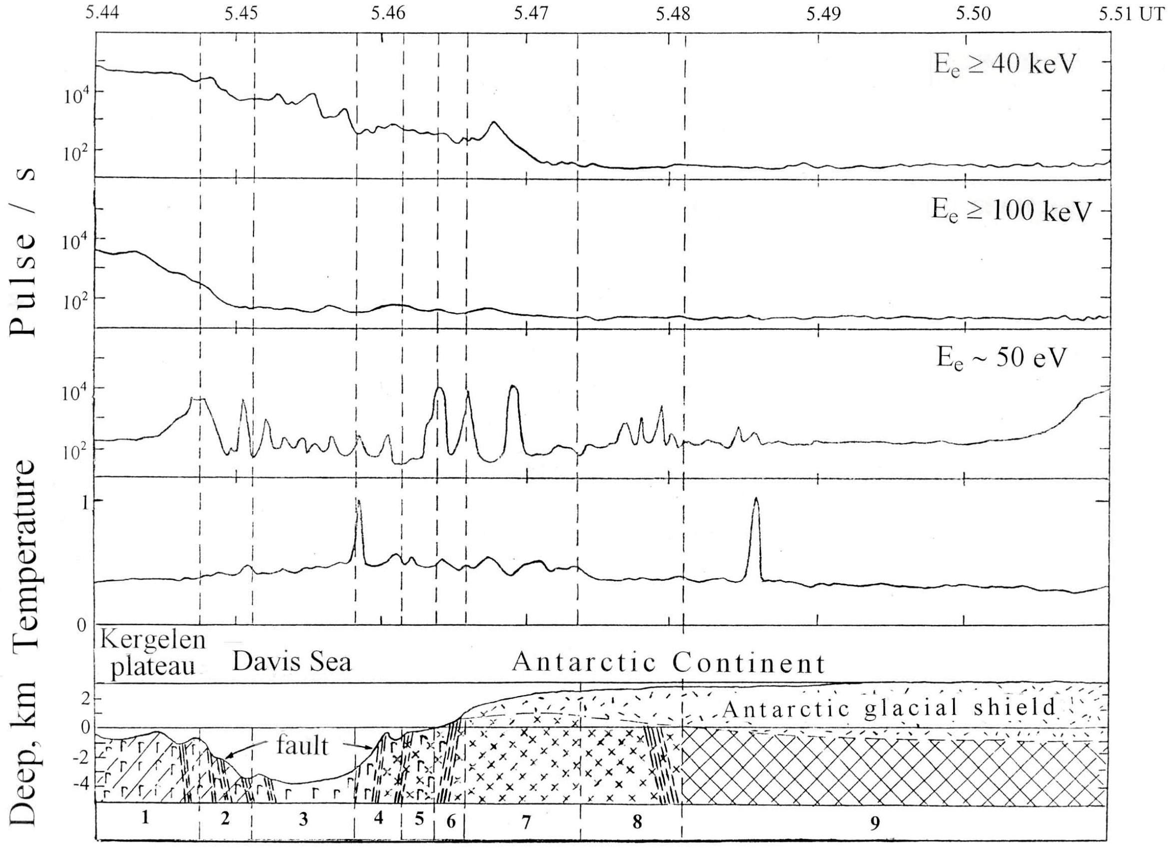

Conditional marks:

PreBaikalian structural complexes of the basement

PreBaikalian structural complexes of the basement activated in Riphean-Paleozoic

Baikalian and Paleozoic structural complexes processed in Mesozoic and Cenozoic

Region of development Mesozoic and Cenozoic volcanism

1 – Kergelen high
2 – system of marginal throwdowns and wrench faults of the Kergelen high
3 – Davis Sea graben-rift
4 – system of marginal throwdowns and wrench faults of the continental slope
5 – Shelf Step
6 – system of shores faults
7 – Queen Mary Coast high
8 – system of sutures faults
9 – Wilkes land Basin

Fig.2 Measured electron fluxes (at the top), plasma temperature and the tectonic structure section along the satellite trajectory (at the bottom).