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Distortion of the results of impedance measurements interpretation on the Kola Peninsula due to the proximity of ionospheric sources of the natural electromagnetic field

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The method of magnetotelluric sounding of the earth's crust is widely used in Arctic regions, when carrying out geophysical work. As is known, this method is based on the impedance approach - measuring the elements of the impedance tensor on the earth's surface in the extremely low-frequency range of electromagnetic waves from natural field sources. The main natural sources of electromagnetic noise are the equatorial centers of thunderstorm activity. In the Arctic regions, in particular on the Kola Peninsula, ionospheric sources of the electromagnetic field, for example, systems of high-latitude ionospheric currents, can also have a noticeable influence on the measurement results. Due to the spatial proximity of these sources to the areas of geophysical work, the plane-wave approximation of the electromagnetic field, on which the impedance approach is based, may be violated. Consequently the results of impedance measurements interpretation may be distorted when determining the geoelectric parameters of the lithosphere. In order to experimentally confirm possible distortions in the impedance measurements interpretation, a joint analysis of data from the induction magnetometer located on the Lovozero geophysical observatory in the center of the Kola Peninsula and satellite geomagnetic data obtained within the AMPERE project was carried out. Dates and time intervals with disturbed and calm geomagnetic conditions over the Kola Peninsula were selected by using satellite data on spatial and temporal variations of the Earth’s magnetic field, as well as on the distribution of the intensity of Birkeland currents, which directly related to zones of intensification of horizontal Hall currents in the high-latitude ionosphere. In 2014, horizontal mutually perpendicular components of the magnetic and electric fields were recorded at the Lovozero magnetometer. Based on these data, the Berdichevsky impedance values were calculated for a given set of frequencies of the natural electromagnetic noise in the range from 0.3 to 27 Hz. The Berdichevsky impedance values were recalculated into the values of the apparent resistance of the earth's crust. As a result of a joint analysis of the data, it was found that on days with calm geomagnetic conditions, the values of the apparent resistivity of the earth's crust are about 100000 Ohm•m, which is inherent to the crystalline Baltic shield within the Kola Peninsula. At the same time, on days with disturbed geomagnetic conditions, the significant decrease of the apparent resistivity values is observed at frequencies below 1 Hz. Perhaps this decrease is determined by the proximity of ionospheric sources of the natural electromagnetic field and the limited use of the impedance approach at high latitudes for high-resistivity rocks. The results obtained are consistent with model calculations of the electromagnetic field from various natural sources.