High-frequency electromagnetic emission in the area between Kamchatka Peninsula and Komandorsky Islands detected by frequency-resonance analysis of remote sensing data

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Abstract: The processing of frequency-resonance using satellite images allowed to detect anomalous zones of high frequency emission in the offshore area between Kamchatka Peninsula and Komandorsky Islands. Nine anomalous zones of high-frequency electromagnetic radiation were detected and mapped in the investigated area. The maximum frequencies of electromagnetic radiation within the contours of detected anomalies are varied from 85 to 1100 MHz. In the local area of anomaly with the maximum frequency value, satellite images recorded at different times were processed: 20/01/2015, 10/01/2017, 10/02/2017, 15/06/2017 and 5/08/2017. An anomalous high-frequency radiation zone was also recorded in the epicenter of a major earthquake on July 17, 2017 near Komandorsky Islands. Results of conducted studies demonstrate the feasibility of studying the nature of electromagnetic emission in the areas of predicted medium to large earthquakes.

Keywords: *Kamchatka Peninsula, Komandorsky Islands, frequency-resonance method, satellite data, mobile technology, RS data processing, high-frequency radiation zone*

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Introduction

In 2016 the features of electromagnetic radiation within areas of past earthquake epicenters location have been studied by authors by the results of remote sensing (RS) data (satellite images) processing and decoding in Republic of Kazakhstan, Japan, Ukraine and Italy. The anomalous responses registration within the surveyed sites was carried out in the frequency range of 20-1350 MHz. The character of the radiation parameters (frequencies and areas) changing with time has been investigated. As a result of studies conducted, the technique of the anomalous areas of high-frequency electromagnetic radiation detection and localization were developed. The investigation results are given in Levashov et al. (2016).

In 2017 the studies of such character has been conducted also within the offshore area between Kamchatka Peninsula and Komandorsky Islands. This area is located in earthquake-prone region. The main goal of the studies – additional approbation of frequency-resonance method of satellite image processing (Levashov et al., 2016 and 2017) for studying the possibility of its application for detection and mapping of local areas of high-frequency electromagnetic radiation in seismically vulnerable regions of the world. Some of the investigations are analyzed below.

Method of research

Mobile technology of frequency-resonance processing and interpretation (decoding) of remote sensing data was used for investigation. Distinctive features of the technology are described in numerous publications, including those cited in Levashov et al. (2016 and 2017).

For many years, this technology has been actively used for prospecting and exploration of ore and combustible minerals. One of the papers (Levashov et al., 2017) presents the results of technology application for the detection and localization of vertical channels for the migration of deep fluids (hydrocarbons, including) in various regions of the world.

The experimental studies in 2016 with this method using in the locations of past earthquakes epicenters showed that the mobile method of remote sensing data frequency-resonance processing can be used to detect areas of high-frequency electromagnetic radiation (Levashov et al., 2016). The method also allows

monitoring the process of occurrence and change (increase and disappearance) in such areas based on the results of processing satellite images of the surveyed sites, obtained at different times (before and after the date of the last earthquake including).

Additional information on the mobile technology used can be found on the website [http://www.geoprom.com.ua/index.php/]. Here a video film is placed, which shows the features of the work at various stages of research, as well as a presentation with numerous results of the practical application of mobile direct-prospecting methods.

Results of reconnaissance (small-scale) studies

The studies in this offshore area have been conducted at a few stages. The obtained results at the first two stages are shown in **Fig. 1**.

At the first stage, a satellite image of the part of the offshore, adjacent to the Kamchatka Peninsula, was processed by the frequency-resonance method on a scale of 1: 200,000. As a result, three anomalous zones NPEMFE-4, NPEMFE-3 and NPEMFE-5 with the maximum frequencies of electromagnetic radiation within their limits of 120, 150 and 85 MHz were detected in the surveyed area (**Fig. 1**).

For further research, a satellite image was taken for the entire area from Kamchatka Peninsula to the Komandorsky Islands for January 10, 2017. The fragment of the obtained image of a relatively small area was processed on a scale of 1: 300,000, and a larger scale 1: 600,000 (**Fig. 1**).

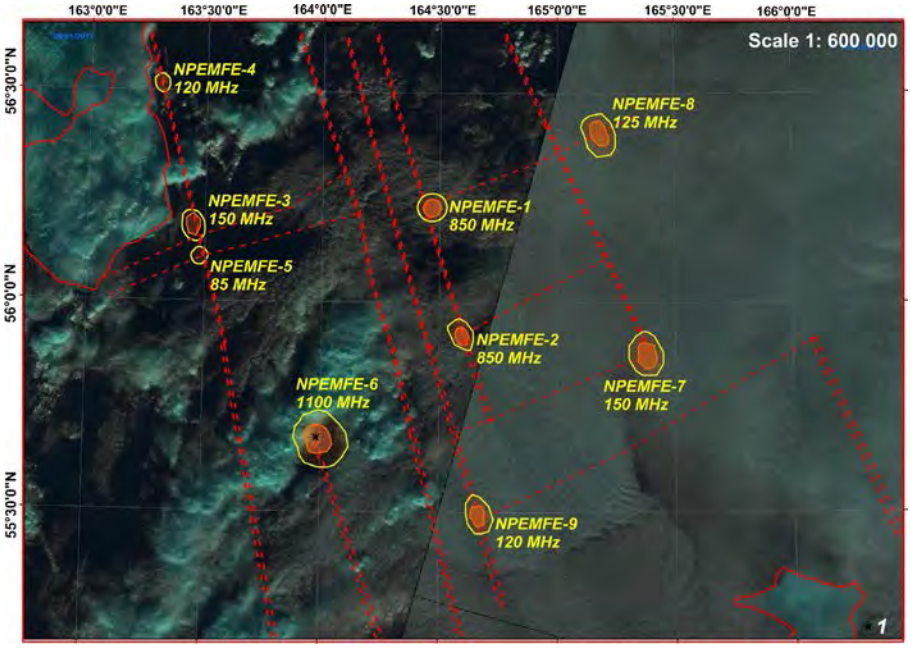


Fig. 1. Sketch-map of the high frequency anomalous zones in the offshore area between the Kamchatka Peninsula and Komandorsky Islands (according to the frequency-resonance analysis of satellite images). Scale of image processing – 1: 600,000. The date of satellite image: 10/01/2017.

As a result of frequency resonance processing of these images, six more anomalous zones of high-frequency electromagnetic radiation were detected and mapped: NPEMFE-1, NPEMFE-2 (at the scale of 1: 300,000) and NPEMFE-6, NPEMFE-7, NPEMFE-8, NPEMFE-9 (1: 600,000 scale) (**Fig. 1**). In the contours of these anomalous zones, the following maximum values of the frequency of electromagnetic radiation were fixed: 850, 850, 1100, 150, 125 and 120 MHz, respectively.

Fig. 1 shows, also taking into account the results of earlier experimental work, Levashov et al., 2016, that the NPEMFE-6 anomalous zone with a frequency of 1100 MHz deserves priority attention. In this connection, additional work was carried out at the location of this anomalous zone.

Satellite images of the local area of NPEMFE-6 anomalous zone location for 20/01/2015, 10/01/2017, 10/02/2017, 15/06/2017 and 5/08/2017 were processed additionally on the scale of 1: 100,000, the results

of the processing are shown in **Fig. 2.**

We pay attention to the fact that for the period from 10/01/2017 to 10/02/2017 the maximum value of the frequency of electromagnetic radiation has not changed. If we take into account that the accuracy of determining the frequency of radiation is 50 MHz, then we can assume that within a month the increase in the maximum value of the frequency of electromagnetic radiation did not exceed 50 MHz.

Moreover, the processing of satellite images of this site for 15/06/2017 and 5/08/2017 shows that the area of the anomalous zones, as well as the maximum value of the frequency of electromagnetic radiation, has significantly decreased. This allows us to conclude that not all anomalous zones of high-frequency radiation discharge energy in the form of an earthquake.

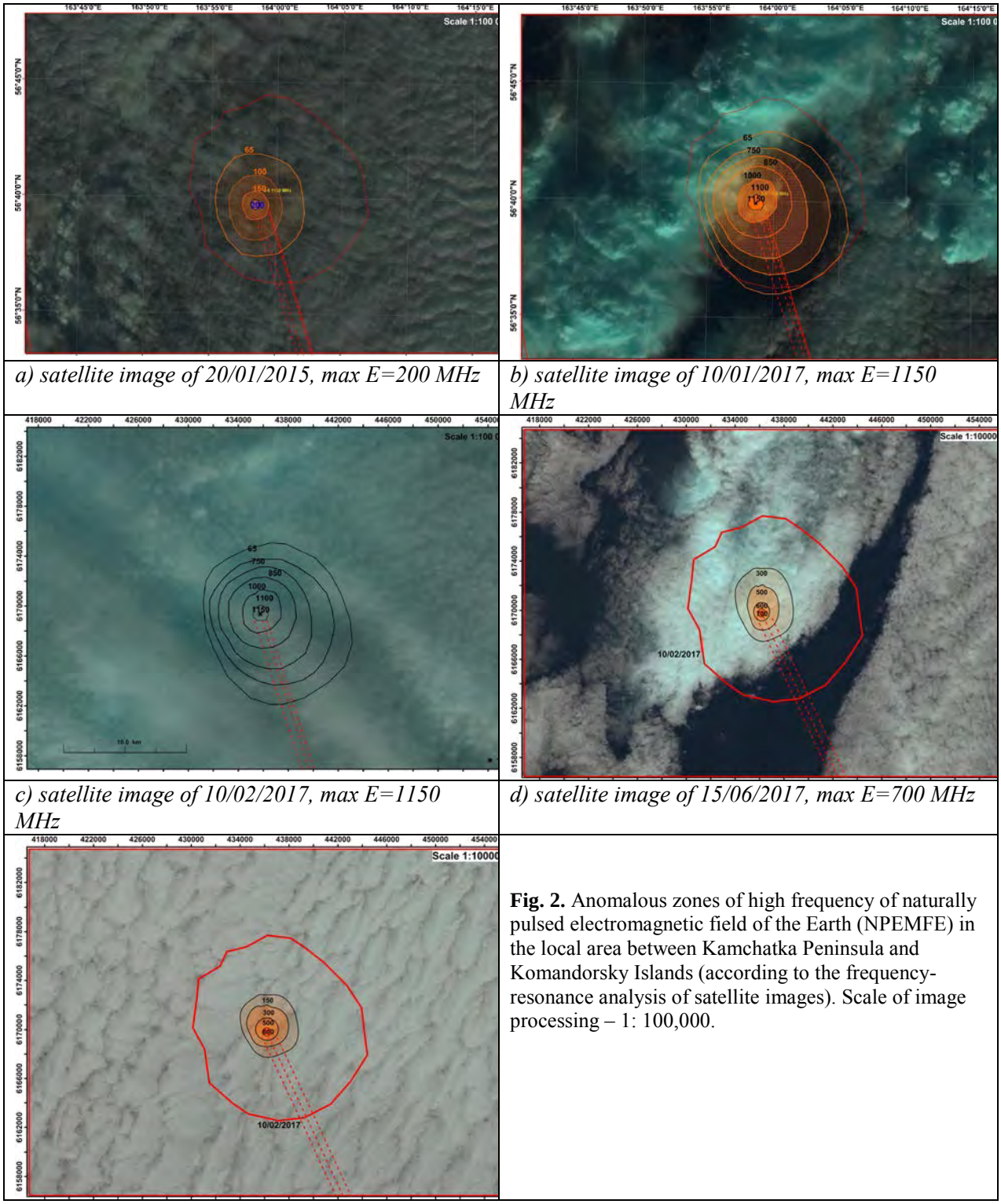


Fig. 2. Anomalous zones of high frequency of naturally pulsed electromagnetic field of the Earth (NPEMFE) in the local area between Kamchatka Peninsula and Komandorsky Islands (according to the frequency-resonance analysis of satellite images). Scale of image processing – 1: 100,000.

e) satellite image of 5/08/2017, max E=600 MHz	

An earthquake on 17 July 2017 in the offshore Kamchatka

Satellite images of the site of the earthquake epicenter for 5/06/2017 (42 days before) and 23/07/2017 (6 days after) were processed on the scale of 1: 100,000. The results are shown in **Fig. 3**.

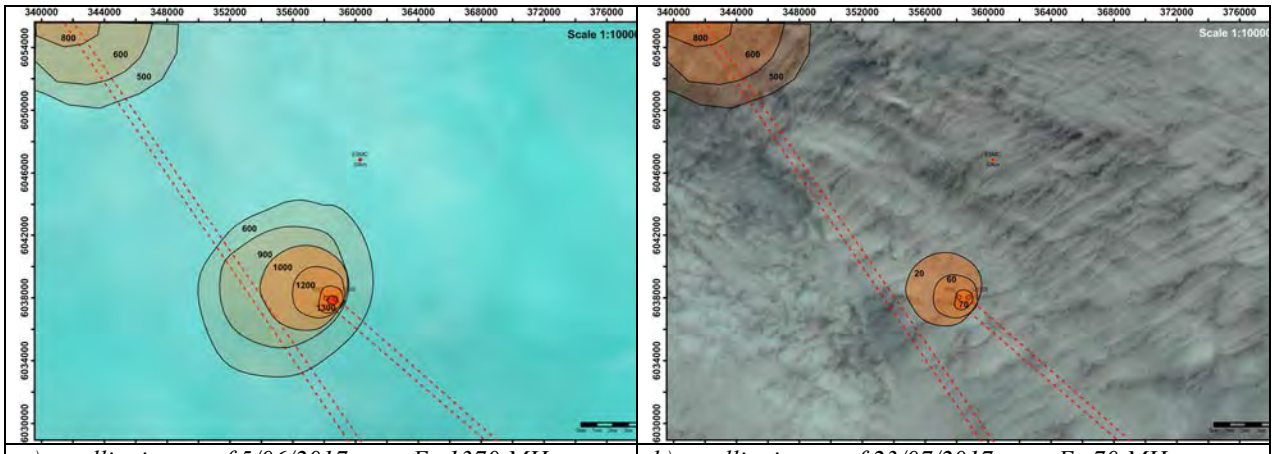
For 42 days before the earthquake in the area of its epicenter, a large anomalous zone of high-frequency radiation was detected and mapped. Within the anomaly, the maximum value of the radiation frequency is 1370 MHz (**Fig. 3a**). Six days after the earthquake, the area of this anomaly significantly decreased, and the maximum value of the radiation frequency decreased to 70 MHz (**Fig. 3b)**.

It can be argued that the conclusions formulated by Levashov et al. (2016) for previously surveyed sites of past earthquakes are valid.

Conclusion

Results of additional studies demonstrate the advisability for further studying the nature of electromagnetic emission in the epicentral area of medium to large earthquakes. In the local areas of the epicenters of past earthquakes, there is an opportunity to study in detail the characteristic features – changes in electromagnetic radiation parameters (frequency and area) with time. The results of these studies can be used in the future to monitor the areas of "predicted" earthquakes.

Technology of the frequency-resonance processing of satellite images in the earthquake-prone areas provides an opportunity to discover and quickly map the anomalous zones of high-frequency radiation. The monitoring for the detected anomalous areas can be organized also by means of ground-based measurements.



a) satellite image of 5/06/2017, max E=1370 MHz	*b) satellite image of 23/07/2017, max E=70 MHz*

Fig. 3. Map of the naturally pulsed electromagnetic field of the Earth (NPEMFE) in the area of the 17.07.2017 offshore Kamchatka earthquake epicenter according to the frequency-resonance processing of satellite images before (a) and after (b) earthquake.

References

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