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Abstract

The new conception for design of system for gathering of seismological information in the form of anormal electromagnetic radiation is proposed. Optimization of the system is carried out. On the basis of obtained result, new method for forcasting of place of expected earthquake is proposed.

NEW CONCEPTION OF DESIGN OF THE SYSTEM FOR GATHERING OF SEISMOLOGICAL PROGNOSTIC INFORMATION AND NEW METHOD FOR FORECAST OF EARTHQUAKES

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The proposed new conception of design of seismological prognostic system [1] includes aimfull use of middle – term prognosis for forming of short – term prognosis and further optimization of the system.

In the considered case, a system of registration of ionospheric airglow is used as a system of the first stage, forming of middle – term prognosis.

System of gathering and registration of electromagnetic radiation of coming from the Earth's entrails at the zone of earthquakes is used as a system of the second stage. Chart diagram of the system is shown in the figure 1, where: 1 – processor's trunk; 2 – Analog – digital convertor; 3 – multichannelled controlled commutator; 4 – processor; 5 - on Earth set of seismological sensors – receivers of Low – frequency electromagnetic radiation; 6 – subsystem used for finding out suggested center of the forecasted earthquake, i.e. for middle – term prognosis. As a subsystem

6, besides Ionospheric airglow detection system, also system of detection of electromagnetic conductivity of rocks may be used.

Optimization of the above system is carried out using principle of dimensionality lowering principle proposed by one of authors in [2].

The optimal system of gathering seismological information should work as follows. After receipt of the signal from the system of registration of ionospheric airglow, supposed co – ordinates of prognosed center of anticipated earthquake are to be computed. Set of seismosensors of the system of short – term prognosis consist of receivers low – frequency electromagnetic radiation and pulse type signals filled by occillating signals of some frequencies. These sensors have a fixed geometrical distance from a suggested center of earthquake. A complete set of sensors may have sizes up to several hundreds of kilometers. Duration of information retrieved from each sensor is to be corrected taking into consideration of information given by system of middle – term prognose.

In the common case, the ratio signal/noise ψ in the channel of propagation of low –frequency electromagnetic radiation from the source of these signals as far as receiver in the first approximation can be found as

$$\psi = \psi_0 + \psi'_F \cdot F + \psi'_L \cdot L, \qquad (1)$$

where $\psi'_F = \frac{\partial \psi}{\partial F}$; F - frequency of electromagnetic radiation; $\psi'_L = \frac{\partial \psi}{\partial L}$; L - distance between source of electromagnetic radiation and seismosensors.

In this article we shall consider the case when, $L_i = const$; $i = \overline{1,n}$; n - number of seismosensors. Henceforth equation (1) can be written as

$$\psi = \psi_{01} + \psi'_F \cdot F, \qquad (2)$$

where $\psi_{01} = \psi_0 + \psi'_L \cdot L$.

During the whole period of information retrieval total amount of gathered information can be found as

$$M_0 = \sum_{i=1}^{n} M_i = \sum_{i=1}^{n} \frac{T_i}{\Delta t} log_2 \left(\psi_{01} + \psi'_F \cdot F + 1\right), \qquad (3)$$

where T_i - duration of information retrieval from the sensor numbered as i.

Then we use a limitation condition

$$\sum_{i=1}^{n} \left(\psi_{01} + \psi'_F \cdot F_i + 1\right) = const$$

or

$$\sum_{i=1}^{n} F_i = const. \qquad (4)$$

A limitation condition (4) means, that band of reasonably received frequencies is limited.

Taking into account of (3) and (4) we can form the functional of effectiveness as follows:

$$\Phi = \int_0^{T_{\max}} \left[\frac{T}{\Delta T} log_2 \left(\psi_{01} + \psi'_F \cdot F + 1\right) + \lambda \left(\psi_{01} + \psi'_F \cdot F + 1\right) \right] dT, \qquad (5)$$

where T - time of information retrieval; λ - multiplier of L'Agrange.

According to the principle of optimal lowering of dimensionality [2], we should find such type of optimal function $L = \varphi(T)$ which would lead the functional of effectiveness (5) to its maximal value.

Solution of above optimization task using Euler's formula gives us following type of said function

$$F = \frac{\psi_0 + 1}{|\psi'_F|} - \frac{T \cdot \psi_0}{T_{\max} |\psi'_F|} \qquad (6)$$

As a result we obtain the possibility to carry out an adaptive control of seismosensors, i.e. whole system of gathering and processing of seismic information. This does mean, that sensor with lowest frequency of received signal should be examined during uppermost time period in order to reach maximal efficiency of the system.

On the basis of above result we can propose a new method for informational forecasting of center of expected earthquakes. We assume that seismosensors are placed on the territory with high seismic risk, forming a rectangular Net (figure 2).

In order to forecast the place of earthquake we should designate a set of values $\{F_i\}$; $i=\overline{1,n}$, and set of values $\{T_i\}$; $i=\overline{1,n}$, where dependence between F_i and T_i should be in line with formula (6), which guarantees reaching of maximum value of total information, gathered from seismosensors. Here we should note, that each sensor consists of n receiver with fixed frequency $\{F_i\}$; $i=\overline{1,n}$.

Hence, each sensor is compound on n number of receiver and makes it possible to receive in the frequency band $\{F_1, F_2, \ldots, F_n\}$.

Selected contour of four seismosensors (in figure 2 they are S_1, S_2, S_4, S_5) will be moved across the high rise territory – area of placement of sensors, and the movement of the contour should be stopped in the point, where the estimated value of functional of effectiveness reaches a maximal value. Such assessment can be realized using computer, which should also control movement of the contour of sensors.

We conclude that a proposed new conception of design of system for gathering prognostic seismological information may increase effectiveness of such systems and make it possible to forecast center zone of expected earthquakes.

References

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2. Asadov H.H. The Principle of dimensionality lowering for synthesis and optimization of a subclass of measuring systems with fading signals on example of remote sensing systems”. Journal: Devices and Systems. Control, Testing, Diagnostics (Published in Moscow) 2003, No. 8, p, 60 – 67.

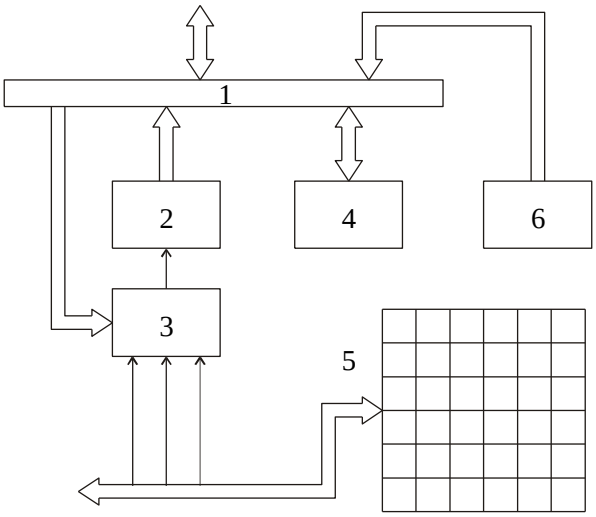

Figure 1: Chart – diagram of the system of gathering and registration of prognostic information.

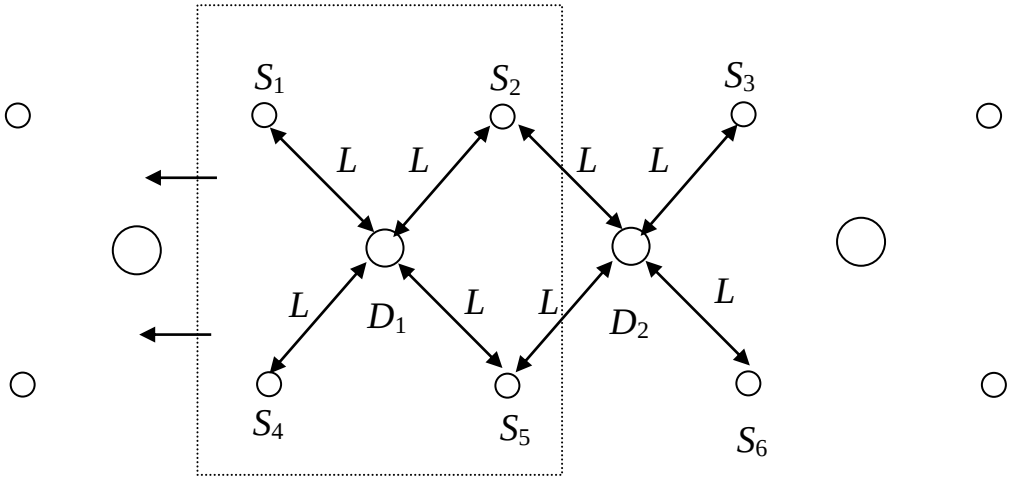

Figure 2: Movement of the contour across the not of sensors.