SEISMIC ACTIVITY CYCLES AND GEOPHYSICAL EARTHQUAKE PRECURSOR FIELDS' VARIATIONS

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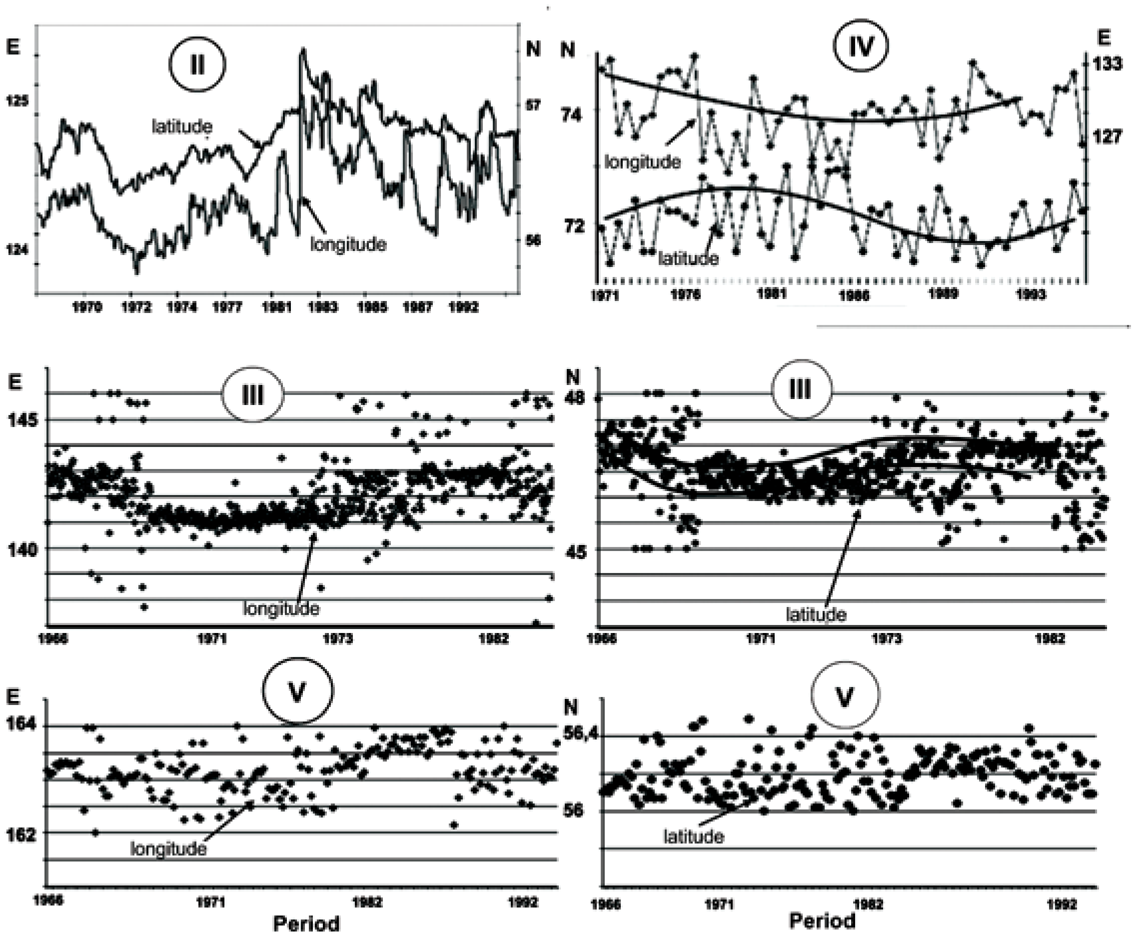
Bases of this paper are statistical modeling materials of geophysical fields and processes linked with seismicity in convergent areas of Northeast Asian lithospheric plates. Were characterized seismic conditions for different parts of seismic belts and pointed out 22-year cycles of seismic activity. Were identified activity areas' displacement vectors for current cycles for 70-80^{ths} period of the XX century. Were marked out aperiodicities of day-night and annual cycling. For annual cycles it is characteristically the increasing of activity in April-June and October-November periods. In day-night distributions of earthquake's amount marks out two or three maximums of activity for characteristic areas of crossing active fractures. Was ascertained the successive activation of multidirectional fault systems in statistical meaning during twenty-four hours. Within the bounds of energy exchange model in global geological medium and Earth crust block structure, shown the uncertainty in forecast of earthquake places on the base of geophysical precursor fields in spatial scales of lithosphere heterogeneity.

Results of seismic processes' statistical modeling

In problem of earthquake forecast by geophysical methods, in particular, by variations of physical fields of gravitational, magnetic, electromagnetic nature, produced by geological medium, in consequence of seismotectonic processes, emerges indefinite situations under the interpretation of experimental investigations. By results of multiple studies, ran in prognostic testing areas in seismoactive regions, we may conclude, that registered precursor aperiodicities of seismic events more, than events itself, with which we could link ascertained aperiodicities. Factually it mean, that geological environment of recording station reacts to dynamic processes of interacting environments "lithosphere-hydrosphere-atmosphere" in global scale. In the second place, aperiodicities of geophysical environment may be caused by wave (or cycle) processes in lithosphere and its interaction in global energy exchange system. Without a solution of two objectives: detection of geological environment reactive response radius on changing of geodynamic conditions and detecting of natural changing of seismoactive areas seismicity itself, advancement in forecasting of earthquakes with geophysical monitoring will be difficult enough.

In this paper there are considered the questions of seismic conditions cycle changing, one of its components is hidden periodicity of seismic activity, which may influence on forming of geophysical earthquake precursor fields.

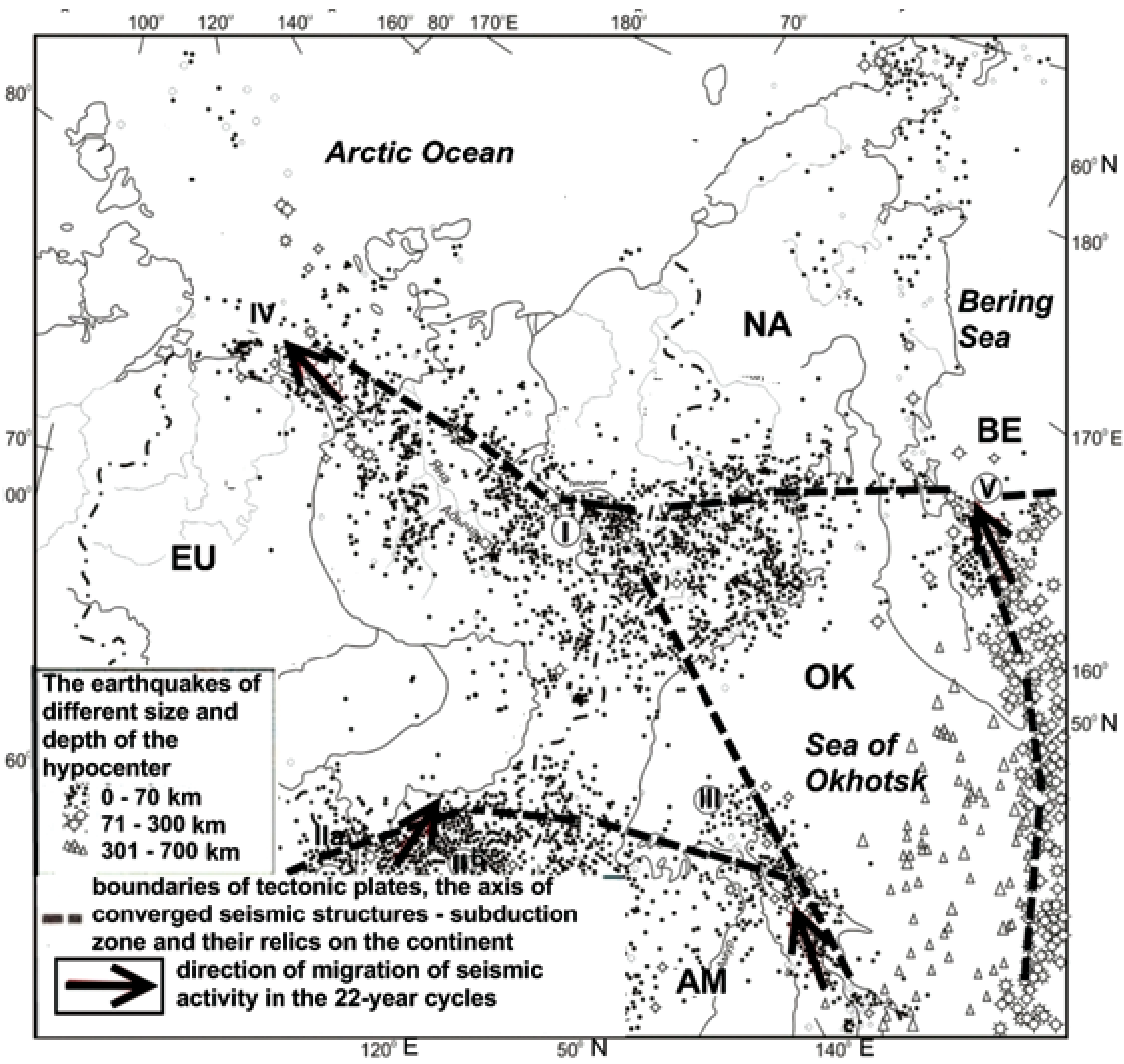
For detection of seismic process hidden periodicities was used the comprehensive approach on the base of different mathematical approach application, which includes traditional statistical methods and working out cluster analysis. Danger zone statistical forecast may be realized with averaged graphic of energy releasing centers migration. In this case every point (latitude-φ, longitude-λ) is some area with taking into account of averaging inaccuracy, in which at the moment (middle of averaging interval) is the most intensive seismic energy release (energy center). Cluster approach permits sorting out of seismic events from the common events' stream, those what doesn't participate in specified regularity processes, what promotes more differentiated (consequently more accurate) discharging of hidden periodicities (Pic. 1, areas 3, 5).



Pic. 1. Seismic activity variations in shape of earthquake epicenters longitude and latitude changing for seismic areas I – V in accordance with Pic. 2 of Northeast Asia seismic belts

II – Baikal-Stanovoi seismic belt; III – Sakhalin-Japan zone; IV – Arctic rift zone; V – Kuril-Kamchatka zone

On the Pic. 2 there are presented fields of Northeast Asia earthquake epicenters distribution in limits of lithospheric plates, where are shown seismic activity migration directions. Earlier such regularity was pointed out for the whole Olekma-Stanovoi area (OSA) and formed seismic field of Tas-Yuryakh earthquake in 1967 with magnitude M7 (areas IIa, IIb, Pic. 2) [Trofimenko, 2007]. The beginning of seismic cycle for OSA refers to 1972 with maximum displacement to the North in 1983. In the area IIb (Pic. 2) the migration of epicenters occurs transversely of main labilized fractures, which have sublatitudinal spreading. In the area IIa the displacement vector is controlled by the crossing fracture system of meridional and sulatitudal spreading.

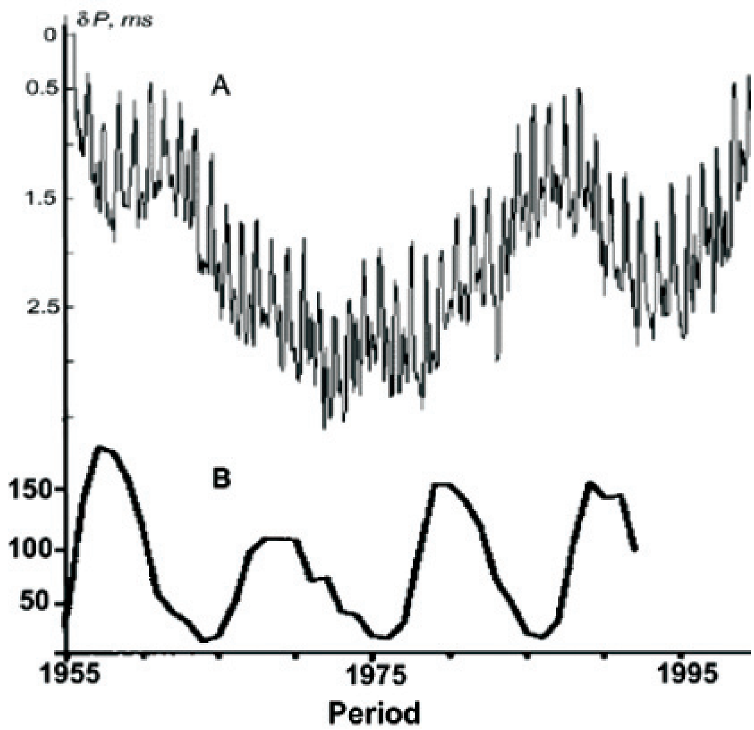


Pic. 2. Boards of lithospheric plates and seismic belts of Northeast Asia (assisted with materials of V.S. Imaev, V.I Ulomov)

Lithoshperic plates (EUA – Eurasian, CHI – Chinese, OKH – Okhotsk-sea zone, NAM – North American, PAC – Pacific); shown the distribution of seismic foci in limits of seismoactive zones: I – Verkhoyan-Kolyma, II-Baikal-Stanovoi (IIa – eastclosure of BRZ, IIb Olekma-Stanovoi zone), III – Sakhalin-Japan, IV – Arctic rift zone, V – Kuril-Kamchatka zone

For separate parts of Sakhalin-Japan, Arctic rift and Kuril-Kamchatka seismoactive zones weredetermines displacement vectors of seismic activity along convergent seismoactive structure's axes to the North starting from the period of 70^{th}, XX century. Duration of the full cycle of seismic activity for all pointed areas is 22 years (Pic. 2).

Independence of seismic activity displacement vectors direction from geodynamic conditions and latitude may testify to the global common perturbation source. Comparison of this regularity with irregularity of Earth rotation suggests, that these events have common regularity, which applies to the period of 70th, XX century. Process of average monthly value deviations of day δP {ms} as a result of Earth's rotating velocity irregularity over a period 1955-2000 is shown on the Pic. 3A. Modern measurement precision permitted to ascertain, that, starting from 1956 until 1961 Earth rotation was increasing, from 1962 till 1972 was slowing down, and from 1973 till our days the Earth increases its rotation [Sidorenkov, 2004].



Pic. 3. Average monthly deviations of earthday duration δP from standard over the period from 1955 till 2000 (A) and solar cycles (B)

On all the presented graphics of seismic activity migration (Pic. 1) age of 70th, XX century traces back as inflection of average curve, or of the minimum of increased epicenter density.

On the graphic (Pic. 3A) is pointed the increasing of rotation 1958-1961 and slowing down 1989-1994. Against the background of perennial changes well seen seasonal variations of earthday duration δP. Earth rotating velocity is the least in April and November, and the most in January and July. January maximum is less than July one. The difference between minimal earthday duration and standard in July and maximal in April or November is 0,0001 s [Sidorenkov, 2004].

Pic. 3B illustrates solar cycles, which influence is usually considered as the initial cause of seismic activity increasing. Increasing of event flux density in 1971-1972 and 1982-1983 is for the zone 3. Similar regularity is typical for zones 2 and 5 over the period 1982-1983 (look at Pic. 1)

Consideration of two possible causes of modified seismic activity indicates that the processes being studied for the interaction ¬ influence shifted over time relative to each other. Moreover, the global solar activity increases at first, and then, after some time - the seismic activity of Earth. According to the authors [Hain, Halilov, 2008], intermediate process between the time of increased solar activity and an increase in seismic activity, leading to delay of seismic activity in relation to the sun, is to increase the stress state of the crust. Establishing a causal relationship between the northern drift of seismicity and the cosmic process at the moment is problematic.

Thus, the cycles of seismic activity occur in the scalar form of the dynamics of activation foci in the energy level and in vector form with migration of earthquake foci within individual parts of the seismic belts of the Northeast Asia. This result is consistent with studies of other regions, in submitted author's review [Khain, Khalilov, 2008]. Changes in seismic activity may not be a source of periodic changes in the physical fields that are produced in three interactive environments "lithosphere-hydrosphere-atmosphere". Investigation of spatio-temporal properties of earthquake seismic zones in Northeast Asia for a variety of geodynamic conditions of deformation processes development established a number of general regularities on which were highlighted areas that are sensitive to rapidly changing geodynamic conditions. For selected areas in the dynamics of seismicity established the identity of the distributions of the earthquakes number during the day and year. For the areas of crossing tectonic structures in day distributions there are point out 2-3 activity maximums and 1-2 maximums in annual (Pic. 4).

By the results of maximum day activity determination for northern board of Amur p,late in assumption of flat wave, made an attempt to ascertain the phase speed of a day seismic activity maximum displacement. The true longitudinal time for pointed zones is: BRZ – 7,4 h, OSA – 8 h, Sakhalin – 9.47 h. Day activity maximums correspondingly – 18, 19 and 20 h UT. Hence the true maximums' time 25,4, 27 and 29,5 hours LT. The difference between maximums in Sakhalin and BRZ is 2 hours, i.e. relative to the prime meridian they are forming simultaneously.

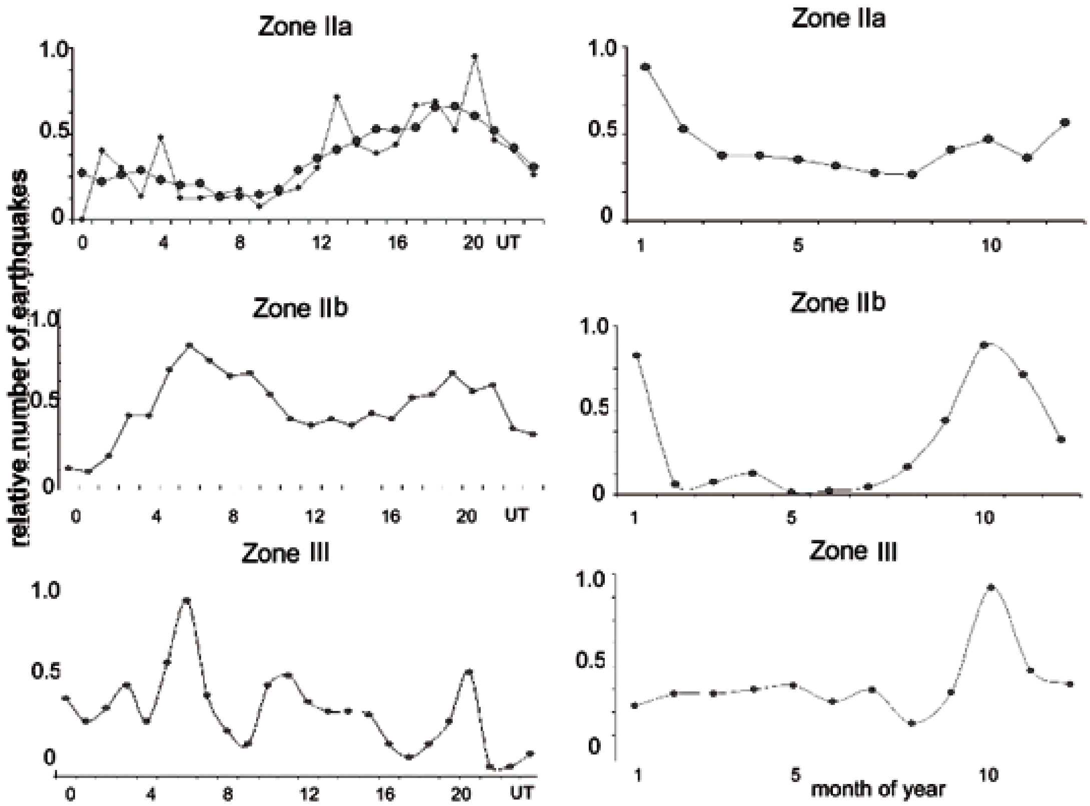
In annual aperiodicities notes the maximum in October-November independent of observable zone's length. The maximum of events in April-June marks out less confidently, what ties with insufficient statistic of taken into account general earthquakes.

Discussion and conclusions on the results of simulation

By geophysical monitoring of geological environment was ascertained the spatial parameter of seismoactive processes influence on physical field aperiodicities' forming in limits of active tectonic structures of Amur plate.

Simulation of geophysical fields and processes by statistical analysis methods, geophysical researches and passive geophysical monitoring of geological environment let us formulate a number of methodic and technology items of geophysical researches of transition zones of lithospheric plates for controlling of geodynamical condition of lithosphere and seismic activity periods forecast.

Made models of geophysical fields and seismic process go into geophysical environment block structure conception



Pic. 4. Earthquakes number distribution pending a day and a year.
IIa – northwest of Baikal rift zone, IIb – central part of Olekma-Stanovoi seismic zone, III – southern part of Sakhalin (according to Pic. 2)

[Sadovsky, 2004]. For such criterion the forecasting of forthcoming seismic event place cannot be distinguished more exact, than the size of domain's spatial parameter [Trofimenko, 2008].

Dynamical gap size after heavy earthquakes independence from earthquake focus inside the area means that at presence of geophysical signs of imminent earthquake, uncertainty of earthquake focus location is equivalent the area, in which limits takes down visible portion of tectonic tension.

Independence of geodynamical system size after energy earthquakes, starting from some threshold energy value, enables forecasting of the threshold (minimum) energy value of coming earthquake (part 2, 4).

Similarity of seismic processes of various seismogenic zones in spatio-temporal scales indicates the global type of seismic regularity appearance. Electromagnetic pulse aperiodicities, registered before the earthquakes in limits of northern board of western, central and eastern flank of Amur plate leads to ambiguity of spatial location of focus in more indefinite scale.

Generalization of received results of geophysical fields' and processes' simulation testifies that, ultimately, with using of geophysical methods are control geodynamic processes in common, and forecasting of separate earthquake places inside the dynamic system determines with the accuracy up to spatial scales of lithosphere inhomogeneities.

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