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Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Satbayev University

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Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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MEDIUM-TERM FORECASTING OF STRONG EARTHQUAKES BY ANOMALOUS VARIATIONS OF THE GROUNDWATER REGIME

Abstract. Medium-term forecast in the system of forecasting strong earthquakes takes a particularly important place, because it is considered to have the highest likelihood of implementation and to facilitate the adoption of specific preventive seismic protection measures. One of the main components of this direction, recognized in the world, is the hydrogeodynamic (HGD) forecast of strong earthquakes based on extreme time anomalies in the regime of groundwater and hydrometeorological factors in seismically active regions. Such work was carried out at the Institute of Seismology of the Ministry of Emergency Situations of the Republic of Kazakhstan within the framework of the project with registration number 0121RK00767 under the program of targeted funding of science in Kazakhstan.

Data from various sources on the following earthquakes were analyzed: 1885 Verny (M=7.3), 1902 Shamakhan (M=7.3), 1911 Kemin (M=8.4), 1938 Kemino-Chu (M=6.8), 1948 Ashgabat (M=7.3), 1970 Sarykamysh (M=6.5), 1975 Khaichen (M=7.1), 1976 Tangshan (M=7.3), 1978 Zhalanash-Tyup (M=6.8), 1990 Baysorun (M=6.4.), 1992 Susamyr (M=7.4). Very valuable information was obtained from the analysis of historical data set forth on ancient seismic events in the historical records of China and Japan over the past 500 years. These sources note that before and after the earthquake, extreme changes occur in the level or in the flow rates, as well as in the temperature and physical properties of groundwater in wells, wells, springs and river flows. At the same time, very contrasting weather conditions and anomalous meteoric precipitation were noted at the same time. In general, as a result, 3 groups of changes in the regime of groundwater over time are noted: the level or discharge of groundwater, up to their disappearance or gushing: temperature and gas-chemical changes preceding and accompanying strong destructive earthquakes, which covered a fairly large territory and a time interval from several years to six months and fits into the framework of the concept of medium-term precursors of earthquakes. Based on the analysis of these data, below, criteria-signs of the preparation of strong earthquakes in hydrometeo-hydrogeodynamic fields are formulated.

Key words: medium-term earthquake forecast, fluid regime, hydrogeodynamic parameters, modular coefficients, hydrometeo-hydrogeodynamic indicators, trends, inversion, gradients.

Introduction. Repeated consideration and analysis of the data of regime observations, as well as historical records noted during the periods of destructive earthquakes in Asia over the past 150 years, show that their occurrence, in addition tobe in gstrictlyconfinedtoclearseis mogenic zones, aredistinguishedby alternating anomalies during thelong-termregime of groundwater and hydrometeorological –factors detected duringthe preparation of large earthquakes.

To study these patterns at the Institute of Seismology of the Ministry of Emergency Situations of the Republic of Kazakhstan, a new method has been developed, based on the calculation and analysis of the long-term variation of modular rainfall coefficients, ground water levels (GWL) or flow rate (Q) of the well, as well as the mode of weak seismicity in the controlled area.

Materials and methods. According to the data of numerous laboratory studies on the deformation of large rock samples, it has been established that the formation of a main rupture - an earthquake, occurs not at maximum loading, but at rapid acceleration of loading [1-6]. When filling large reservoirs (Toktogul, Nurek hydroelectric power plants in Central Asia, etc.), the main number of tangible earthquakes occurred precisely during the accelerated filling of large reservoirs. Hence, it follows that the stability of the geodynamic equilibrium of tectonic structures is disturbed by the spontaneous extreme impact of anomalous stresses on these systems. Such regularity in the model can be seen at seasonal peaks in the formation of the course of weak seismicity in seismically active regions, which is undoubtedly associated with the amount of precipitation [7,8]. Based on the above, it seems reasonable to search for new medium-term precursor criteria for strong earthquakes precisely in the gradient course of the change in the water permeability or the flow rate of wells Q (w).

Table 1 - The main criterion (signs) for the medium-term forecast of strong earthquakes (SEQ) in hydrogeodynamic fields (according to A.U. Abdullaev, 2020)

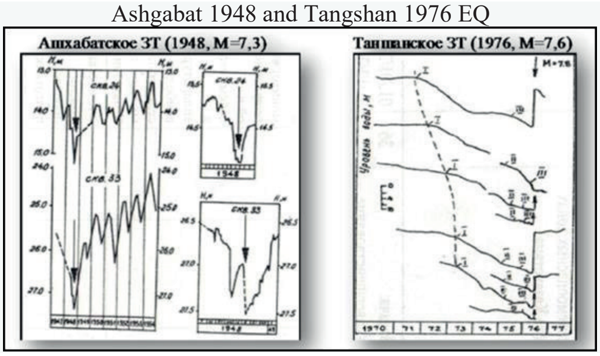
№	Main criteria and forms of display	The time of display of the precursor (sign)	Precursor form	Waiting time before the earthquake
1	Long-term abrupt decrease in the GWL to the minimum level and its transition to a reverse increase (inversion) with the preservation of the annual seasonal wave (Ashgabat-Khaichen form)	2-5 years	Horse racing, rapid descent min. level and reverse (inversion) in the form of a wedge, bay and takeoff	1-2 years
2	Change in water temperature	1-2 years	Temperature changes (from 1 to 10°C) in the form of a bay or hump	Within six months, a year
3	Change in taste (salt content) of water (Kemin-Verny-Chuform)	0.5-2 years	Drought or protracted rains, floods	During a year
4	Protracted weather anomalies (continuous rains, drought).	1-2 years	Destruction and failure of the seasonal run of the GWL and Q(w).	For months
5	Resynchronization of the course of precipitation and PRW, and the formation of a destructive seasonal course	1-3 years	Resynchronization of the course between meteorological precipitation and UPV, destruction	0.5-1.5 years
6	Destruction of the regularity, and the form of the classical seasonal variation of the water flow rate or the flow rate of ascending water flows in wells	0.5-2 years	Destruction of small hydrogeological cycles (4 ± 2) in the groundwater regime, against the background of 11-year hydrogeological cycles and solar activity	Year, sixmonths
7	Destruction (lengthening or shortening) or disappearance of hydrogeological periodicities of various ranks	2-6 years old, 11 years old		Year

To implement this concept, the studies were carried out in two directions: in the retrospective analysis of all the strongest earthquakes and the search for new criteria for the medium-term forecast of strong earthquakes, based on the continuous tracking of gradient anomalies in the long-term course of the GWL (Qw) in seismically active regions. In this vein, at stage 1 (2018-2019), all possible displays of hydrometeorological and hydrogeological anomalies in the groundwater regime were studied before the occurrence of destructive earthquakes (M≥7), according to historical sources from China, Central Asia and Kazakhstan, which occurred in the 17th-20th centuries. It was revealed that the anticipatory effects of such earthquakes are noted in the form of weather anomalies and, most importantly, abrupt drops in the level of groundwater, springs or their outpouring (see Fig. 1), the appearance of an unusual taste, smell and gas jets, etc., which means a change in their chemical composition. These anomalies manifested themselves over a large area for 3-4 months to a year, and in the GWL - for several years in the focal areas and beyond the occurrence of large earthquakes [2,4-6]. These data turned out to be very important for the development of the main criteria for medium-term forecasting of earthquakes, which are systematized in the form of a table [7,8].

It was revealed that the medium-term forecast criteria are found in the continuous long-term course of meteoric precipitation and long-term variations in the GWL in the field of preparation of strong earthquakes for a long time, covering several years over a fairly large area (see Fig. 1).

To identify the systemic criteria for a medium-term forecast, we studied the long-term course of specially calculated modular coefficients of the GWL or the flow rate of wells Mk (Q) and the meteoric precipitation Mk (Opr) in these areas, as well as the air temperature Mk (Tatm) in a continuous multi-year mode using the example of the Almaty prognostic polygon (APP) in southeastern Kazakhstan.

Ashgabat 1948 and Tangshan 1976 EQ



BaysorunEQ(1990, K=15.3)

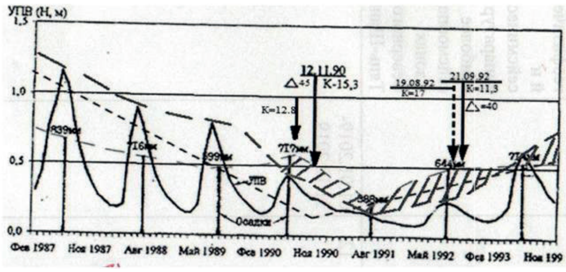


Fig. 1. Examples of display of MT HGD anomalies before the strongest earthquakes in Central Asia. The precursor move is expressed in the form of a wedge, a stepped descent with explosions, or a bay.

On the basis of continuous long-term HGD observations in Kazakhstan for more than 40 years [9,10], the modular coefficients of GWL (Qw), precipitation, air temperature (Ml and Mpr, Mk (Q), Mkt^{0}) were calculated for the last 22 years (1998-2020). For all deep wells (Tau-Turgen, Alma-Arasan, Gorelnik, Kuram, Izvestkovy) located in the Zaili-Ketmenseis mogenic zone. These modular coefficients were formed by calculating the average monthly and average annual values of these parameters, and then bringing them to the average long-term level of these indicators for the entire observation period. The calculated modular coefficients for GWL (Ml) or flow rate Mk (Q), as well as for sediment Mk (Opr), were carried out for deep wells, the depth of which is 300 - 500 m. and more.

Results and Discussion. *Correlation of the course of modular coefficients and strong earthquakes.* For this, only strong earthquakes with K≥14 (Ms≥5.5) were selected, which occurred on the territory of South-East Kazakhstan within a radius (R) of up to 200 km from observation points, according to the models of the assumed area of distribution of precursor anomalies according to the formula , where R is the radius of development of the precursors, M is the magnitude of the earthquake [1].

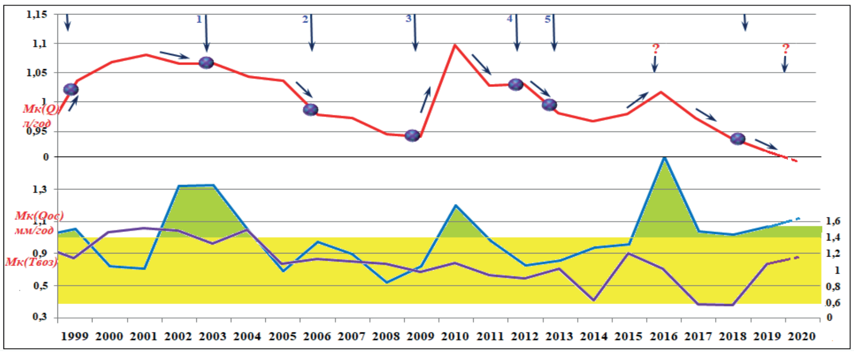


Fig. 2. Gradient jumps in the long-term variation of modular coefficients and the time of occurrence of strong earthquakes at st. Tau Turgen APP; arrows - gradient direction, vertical arrows-strong earthquakes.

As can be seen in Fig. 2, all large earthquakes in the southern part of the APP that occurred in 2003, 2006, 2009, 2012, 2013 with К≥14, as well as additionally weak earthquakes with К <12, К≤12 that occurred in 1999 and 2018-2019. It should be noted that over the entire observation period, there was a steady trend decrease in oil permeability in wells and in general in the Zailiy-Almaty zone. Analysis of the long-term course of the Mpr showed that it is generally stable and fluctuates in a stable corridor with some anomalies in 1997-2003, 2006-2007, 2010-2011 and 2017. In its course, the internal wave periodicity of 3-5 years is clearly noted. Meanwhile, the course Mk (Q) is completely different, autonomous, with its own periodicity (5 - 10 years) with a clear steady downward trend. Against this background, it is established that the breakdown of the gradient course Mk (Opr) is ahead of the course Mk (Q) by a year (± 3 months). In fig. 2, it is clearly seen that each major earthquake occurs on the segment of acceleration or change of sign to the opposite (-) of the gradient course of the GWL (Qw). The anomalous gradient precursor segment leads the event from six months to 2 years, which fit into the medium-term forecast (see Fig. 2, arrows on the curve).

These results indicate that the dynamic instability in the focal zones of the upcoming earthquakes is caused by the "reversal" of the gradient course, and the realization of earthquakes occurred during jumps (breaks) of these factors. Hence, it can be concluded that large earthquakes are prepared under conditions of abrupt fluid saturation, or, conversely, "draining" of the geological environment in seismogenic structures. Consequently, such conditions are undoubtedly one of the necessary for the occurrence of large earthquakes and, therefore, can be considered as criteria for medium-term anomalies.

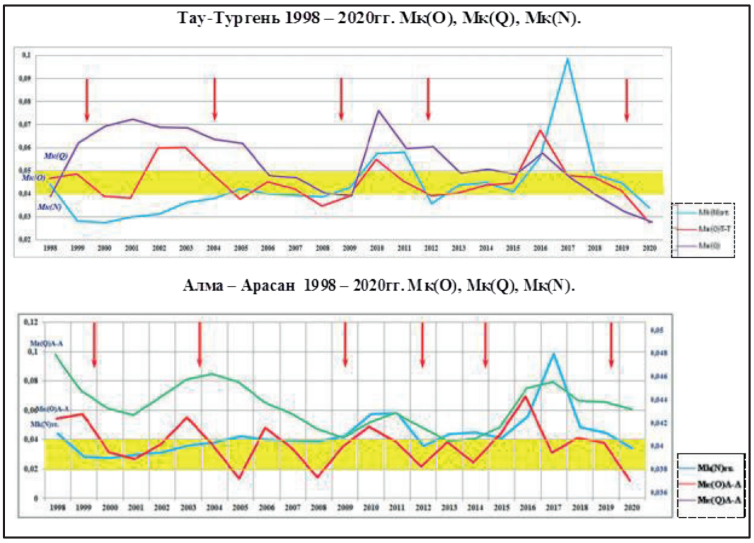


Fig. 3. Long-term synchronous movement of modular coefficients(Mk (Opr), Mk (Q), Mk (N))in the groundwater regime at the APP according to the data of deep wells.

Shaded bar - background precipitation level, vertical linesthe moment of realization of strong earthquakes at st. Tau-Turgen, Alma-Arasan.

It should be noted that in the course of the modular coefficient of GWL (Qw) for the period 1998-2020 in deep wells, the reflection of 11 year hydrogeological cycles is clearly visible: from 1998 to 2009 and from 2010 to 2020, which fit into the 23rd and 24th cycles of solar activity, characterized by the lowest values of the Wolf number (W) over the last 100 years.

Next, the modular seismic mode coefficients Mk (N) were calculated as the sum of the course of earthquakes with K=7, 8, 9 over the last 40 years for the territories of the APP. It was found, in the last decade, especially in 2016 and 2017 it is noted that weak seismicity increases sharply, and since 2018 dropped sharply (see Fig. 3.4). At the same time, it is during this period that there is a deficit of strong earthquakes from K≥15-16 at the APP. A joint analysis of the synchronous course in time of the main modular groundwater coefficients unambiguously shows that the course of weak seismicity is completely determined by the course of the modular coefficient of precipitation, ahead of the course of seismicity by a year ± 3 months (Fig. 4). Thus, a temporary hydrogeodynamic regularity is established, expressed in the interdependence in the time of the course of the triad Mk (Opr) → Mk (Q) → Mk (N) (Fig. 3,4), where earthquakes occur on the segments of gradient anomalies and their sign changes (+), (-). This provision allows us to develop a new model, a more universal methodology for medium-term forecasting of strong earthquakes based on gradient anomalies in the synchronous course of modular groundwater coefficients.

Temporal changes in the hydrometeo-hydrogeodynamic parameters of groundwater, determined in the mode of deep wells and ascending springs in the controlled area, is the most reliable indicator of the medium-term forecast of strong earthquakes. At the same time, the most important indicators are the destruction and inversions of the intra-annual course of changes in precipitation and GWL against the background of its regular long-term position with the formation of various exotic types of anomalies such as “wedge”, “bay”, “shelf” and “hump”. The task of forecasting in this case is the identification of extreme segments - in the "breaks" of the gradient course of continuous data and to find these images, to calculate the probable advanced time of the possible realization of impending earthquakes.

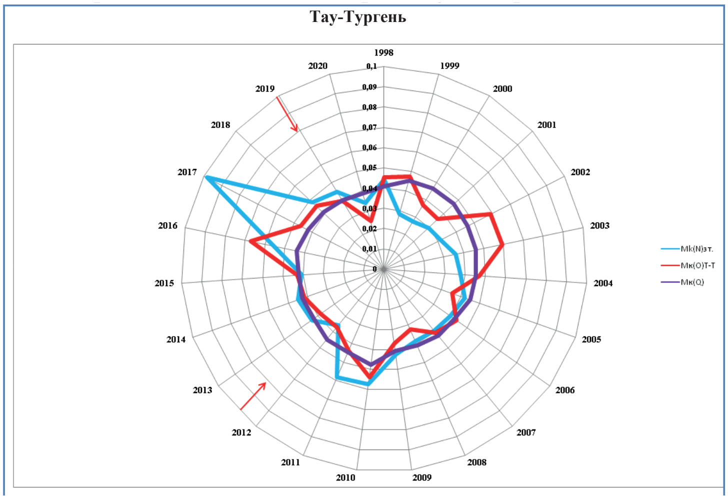


Fig. 4. Synchronization of modular coefficients (Mk (Opr), Mk (Q), Mk (N)) on a pie chart. The sharply distinguished maximum values of Mk (Opr) are clearly visible, which determine the seismic regime and the occurrence of strong earthquakes with K≥13 (arrow).

Algorithm and technology of forecasting. They consist of the following step-by-step actions:

1. Determination of base points (wells) for calculating modular coefficients of long-term variation of parameters in the predicted area.

2. Calculation, modular coefficient Mk (Opr) for the entire observation period by months, years and decades.

3. Calculation of monthly, annual and long-term values of oil flow rate or flow rate (Q) in wells. Calculation of the modular coefficient Mk (Q) for wells for the entire observation period.

4. Calculation of the modular coefficient of the seismic regime Mk (N) for weak earthquakes (K = 6-9) for the entire observation period and determine its main frequency and trends.

5. Compile the series of strong earthquakes for the territory of the Almaty prognostic polygon (APT) with K≥13 and study their temporal sequential periodicity.

6. Find on the curves of the gradient course of modular coefficients Mk (Opr), Mk (Q), Mk (N) the main anomalous segments ("breaks") and change of their signs (+), (-) and calculate the time of anomalous values of modular coefficients.

7. Analyze the identified anomalies in retrospect and calculate the waiting time for new earthquakes.

8. Determine the areal displays of anomalous gradients at the test site, based on the theory that the radius of display of HGD earthquake precursors in the earthquake preparation zones are in the ratio $R = 10^{0.43M}$, where R is the radius of display of anomalies, M is the magnitude of the expected earthquake.

9. Probabilistic assessment of the forecast.

Conclusion. The first approbation of this technique was carried out when assessing the course of HGD and HGH parameters when compiling a comprehensive map of medium-term forecast of strong earthquakes for 2019-2020 on the APP, where she found confirmation.

The novelty of this technique consists in: 1. The gradient course of modular coefficients was used for the first time: Mk (Opr), Mk (Q), Mk (N) of groundwater; 2) the forecast is carried out taking into account the control parameters of the internal and external influence.

A new technique for medium-term forecasting of strong earthquakes has been developed and for the first time not the change in the groundwater level itself is involved, but the gradient changes in the course of time, the precipitation in the controlled area, which directly causes the formation of gradients in the course of the hydrogeodynamic regime of groundwater and the seismic process.

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ЖЕР АСТЫ СУ РЕЖИМІНІҢ АНОМАЛДЫ ӨЗГЕРУЛЕРІ БОЙЫНША КҮШТІ ЖЕР СІЛКІНІСІН ОРТА МЕРЗІМДІ БОЛЖАУ

Аннотация. Күшті жер сілкіністерін болжау жүйесінде орта мерзімді болжам ерекше маңызды орын алады, өйткені жүзеге асырудың ең жоғары ықтималдылығы және сейсмикалық қорғаудың арнайы алдын алу шараларын қабылдауға ықпал ету болып саналады. Әлемде мойындалған бұл бағыттың негізгі құрамдас бөліктерінің бірі сейсмикалық белсенді аймақтардағы жер асты суларының режиміндегі экстремалды уақыт ауытқулары мен гидрометеорологиялық факторлар негізінде күшті жер сілкінісінің гидрогеодинамикалық (ГГД) болжамы болып табылады. Мұндай жұмыстар ҚР Төтенше жағдайлар министрлігінің Сейсмология институтында Қазақстан ғылымын мақсатты қаржыландыру бағдарламасы бойынша 0121RK00767 тіркеу нөмірі бар жоба аясында жүргізілді.

Төмендегі жер сілкіністері бойынша әртүрлі дереккөздерден алынған мәліметтер талданған: Верный 1885 (М=7,3), Шемахан 1902 (М=7,3), Кемин 1911 (М=8,4), Кемино-Чуй 1938 (М=6,8), Ашхабад 1948 (М=7,3), Сарықамыш 1970 (М=6,5), Хайчен 1975 (М=7.1), Таншан 1976 (М=7,3), Жалаңаш-Түп 1978 (М=6,8), Байсорын 1990 (М=6.4.), Сусамыр 1992 (М=7,4). Қытай мен Жапонияның соңғы 500 жылдағы тарихи жазбаларындағы көне сейсмикалық оқиғалар туралы баяндалған тарихи деректерді талдау нәтижесінде өте құнды мәліметтер алынды. Бұл дереккөздер жер сілкінісіне дейін және одан кейін ұңғымаларда, құдықтарда, бұлақтарда және өзен ағындарында жер асты суларының деңгейінде немесе дебитінде, сондай-ақ температура мен физикалық қасиеттерінде төтенше өзгерістер болатынын атап өтеді. Бұл ретте өте қарама-қайшы ауа райы жағдайлары мен аномальды метеорлық жауын-шашын бір мезгілде байқалды. Жалпы алғанда, жер асты суларының режимінің уақыт бойынша өзгеруінің 3тобын атап өтуге болады: жер асты суларының деңгейі немесе ағызуы, олардың жоғалуына немесе атқылауына дейін: температура мен газ-химиялық өзгерістердің күшті жойқын жер сілкіністерінің алдындағы және олармен бірге жүретін өзгерістері. жеткілікті үлкен аумақ және бірнеше жылдан алты айға дейінгі уақыт аралығы және жер сілкінісінің орта мерзімді прекурсорлары тұжырымдамасының шеңберіне сәйкес келеді. Осы мәліметтерді талдау негізінде төменде гидрометео-гидрогеодинамикалық кен орындарында күшті жер сілкіністерін дайындаудың критерий-белгілері тұжырымдалған.

Түйінді сөздер: жер сілкінісінің орта мерзімді болжамы, сұйықтық режим, гидрогеодинамикалық параметрлер, модульдік коэффициенттер, гидрометео-гидрогеодинамикалық көрсеткіштер, тенденциялар, инверсия, градиенттер.

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СРЕДНЕСРОЧНОЕ ПРОГНОЗИРОВАНИЕ СИЛЬНЫХ ЗЕМЛЕТРЯСЕНИЙ ПО АНОМАЛЬНЫМ ВАРИАЦИЯМ РЕЖИМА ПОДЗЕМНЫХ ВОД

Аннотация. Среднесрочный прогноз в системе прогнозирования сильных землетрясений занимает особо ответственное место, т.к. считается, что он имеет наибольшую вероятность реализации и способствует принятию конкретных превентивных мер сейсмозащиты. Одним из основных составляющих этого направления, признанных в мире, являются гидрогеодинамический (ГГД) прогноз сильных землетрясений по экстремальным временным аномалиям в режиме подземных вод и гидрометеофакторов в сейсмоактивных районах. Такая работа проведена в Институте сейсмологии МЧС РК в рамках проекта с регистрационным номером 0121РК00767 по программе целевого финансирования науки в Казахстане.

Анализированы данные из различных источников по следующим землетрясениям: Верненское 1885 г. (К=7.3), Шемахинское 1902 г. (М=7.3), Кеминское 1911 г. (М=8.4), Кемино-Чуйское 1938 г. (М=6.8), Ашхабадское 1948 г. (М=7.3), Сарыкамышское 1970 г. (М=6.5), Хайченское 1975 г. (М=7.1), Таншанское

1976 г. (M=7.3), Жаланаш-Тюпское 1978 г. (M=6.8), Байсорунское 1990 г. (M=6.4.), Сусамырское 1992 г. (M=7.4). Весьма ценные сведения получены при анализе исторических данных, изложенных по древним сейсмическим событиям в исторических записях Китая и Японии за последние 500 лет. В этих источниках отмечается, что до и после землетрясения возникают экстремальные изменения в уровне или в расходах, а также температуре и физических свойствах подземных вод в скважинах, колодцах, родниках и потоках рек. Вместе с тем одновременно отмечались весьма контрастные погодные условия и аномальные метеорные осадки. В целом, в итоге отмечаются 3 группы изменения режима подземных вод во времени: уровень или расход подземных вод, вплоть до их исчезновения или фонтанирования: температурные и газохимические изменения, предшествующие и сопутствующие сильным разрушительным землетрясениям, которые охватывали достаточно большую территорию и временной интервал от нескольких лет до полугода и укладывается в рамки понятия среднесрочных предвестников землетрясений. На основе анализа этих данных ниже сформулированы критерии – признаки подготовки сильных землетрясений в гидрометео-гидрогеодинамических полях.

Ключевые слова: среднесрочный прогноз землетрясения, флюидный режим, гидрогеодинамические параметры, модульные коэффициенты, гидрометео-гидрогеодинамические показатели, тренды, инверсия, градиенты.

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REFERENCES

[1] Abdullaev A.U. (2002) Fluid regime of the earth's crust as a reflection of modern geodynamic processes (on the example of the Tien-Shan). // Almaty. Evero. P.352.

[2] Abdullaev A.U. (2017) Hydrogeological anomalies of the Kemin catastrophic earthquake of 1911. (in connection with the 100th anniversary of the event). Modern problems of geodynamics and geoecology within continental organisms. // On the example of the reports of the V international symposium, - volume 1. P.18-25.

[3] Kovalevsky V.S. (1976) Long-term fluctuations in the level of groundwater and groundwater.// M. Science, P. 270.

[4] Hydrogeology of the USSR v. XXXVII. East Kazakhstan, M. 1980.308s.

[5] Milkis M.R. (1984) Hydrogeological precursors of the Ashgabat earthquake of 1948. Hydrogeological precursors of the earthquake. // M. Science, P. 76 - 94.

[6] Sobolev G.A. (1993) Basics of earthquake prediction. // M.: Science.

[7] (1980) Natural anomalies preceding earthquakes "Beijing", Seismology Publishing House, P.205 (in Chinese).

[8] (1984) Hydrogeodynamic precursors of earthquakes. M. IFE. ASthe USSR. P.155.

[9] Shtanglev E.S. (1983). The relationship between seismic activity and the regime of surface and groundwater. Physics of the Earth, No. 3, P. 96-102.

[10] (1988) Hydrogeochemical and hydrogeodynamical studies at the prognostic ranges of Kyrgyzstan. Publishing house Ilim, Frunze, P. 154.

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