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«Central Asian Academic Research Center» LLP is pleased to announce that "News of NAS RK. Series of Geology and Technical sciences" scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of Geology and Technical Sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

«Орталық Азия академиялық ғылыми орталығы» ЖШС «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. Web of 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.

ТОО «Центрально-азиатский академический научный центр» 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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SEISMOTECTONIC MODEL OF SOUTHERN KAZAKHSTAN AS A BASIS FOR SEISMIC HAZARD ASSESSMENT

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Abstract. In seismological and seismotectonic respects, the Aral-Karatau seismically dangerous region, which includes Southern Kazakhstan, has not been sufficiently studied. However, for this region there are detailed geological and geophysical materials, the capacity of the earth's crust, active mantle, etc. At different times, seismic events with a magnitude of M=2.5-7.5 were recorded on the territory of Southern Kazakhstan, which indicates the presence of potentially dangerous seismogenic zones with the maximum magnitude of expected earthquakes. These zones are sources of powerful dynamic impacts on the geological environment, and through it - on various building structures and the human habitat. According to established concepts, the activity of seismic regions is predetermined by the previous history of their geological development, especially at the last neotectonic stage. A regional seismotectonic model (Map of seismogenic zones) of real and potential zones of occurrence of earthquake sources in the studied territory has been developed based on a set of geophysical, geological-tectonic and seismological data. The seismotectonic model is the basis for seismic intensity calculations in a probabilistic variant, as well as for forecasting seismic impacts in peak ground accelerations. The map of tectonic faults of Southern Kazakhstan can be used in various seismotectonic and geodynamic constructions, including those of an applied nature for forecasting dangerous natural processes associated with the destruction of the earth's crust. Together with the database, it is a solid foundation for the accumulation of information, its tectonophysical analysis and the development of other cartographic projects, which will allow a deeper understanding of the features of the seismotectonic process of Southern Kazakhstan.

Keywords: тectonic fault, seismotectonic model, seismic potential

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СЕЙСМИКАЛЫҚ ҚАУІПТІ БАҒАЛАУДЫҢ НЕГІЗІ РЕТІНДЕ ОҢТҮСТІК ҚАЗАҚСТАННЫҢ СЕЙСМОТЕКТОНИКАЛЫҚ МОДЕЛІ

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Аннотация. Сейсмологиялық және сейсмотектоникалық қатынастарда Оңтүстік Қазақстанға жататын Арал-Қаратау сейсмикалық қауіпті өңірі жеткілікті зерттелмеген. Алайда, бұл аймақ үшін егжей-тегжейлі геологиялық-геофизикалық материалдар, жер қыртысының қуаты, белсенді мантия және т.б. бар. Әр уақытта Оңтүстік Қазақстан аумағында M=2.5-7.5 магнитудасы бар сейсмикалық оқиғалар тіркелді, бұл күтілетін жер сілкіністерінің ең жоғары магнитудасы бар ықтимал қауіпті сейсмогендік аймақтардың болуын көрсетеді. Бұл аймақтар геологиялық ортаға, ал ол арқылы әртүрлі құрылыс құрылымдарына және адамның қоршаған ортасына күшті динамикалық әсер ету көздері болып табылады. Үстемдік ететін идеяларға сәйкес, сейсмикалық аймақтардың белсенділігі олардың геологиялық дамуының бұрынғы тарихымен, әсіресе соңғы неотектоникалық кезеңде алдын ала анықталған Геофизикалық, геологиялық-тектоникалық және сейсмологиялық мәліметтер кешені негізінде зерттелетін аумақтағы жер сілкінісінің нақты және ықтимал аймақтарының аймақтық сейсмотектоникалық моделі (сейсмогендік аймақтар картасы) әзірленді. Сейсмотектоникалық модель ықтималдық нұсқада сейсмикалық қарқындылықты есептеу үшін, сондай-ақ жер үсті жылдамдығының ең жоғары жылдамдығында сейсмикалық әсерлерді болжау үшін негіз болып табылады. Оңтүстік Қазақстандағы тектоникалық жарылымдар картасы әртүрлі сейсмотектоникалық және геодинамикалық құрылыстарда, соның ішінде жер қыртысының бұзылуымен байланысты қауіпті табиғи процестерді болжау үшін қолданбалы сипаттағы құрылыстарда қолданылуы мүмкін. Мәліметтер қорымен бірге ол ақпаратты жинақтаудың, оны тектонофизикалық талдаудың және басқа да картографиялық жобаларды әзірлеудің берік негізі, бұл Қазақстанның оңтүстік-шығысындағы сейсмо-тектоникалық процестің ерекшеліктерін тереңірек түсінуге мүмкіндік береді.

Түйін сөздер: тектоникалық жарылым, сейсмотектоникалық модель, сейсмикалық потенциал

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СЕЙСМОТЕКТОНИЧЕСКАЯ МОДЕЛЬ ЮЖНОГО КАЗАХСТАНА КАК ОСНОВА ОЦЕНКИ СЕЙСМИЧЕСКОЙ ОПАСНОСТИ

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Аннотация. В сейсмологическом и сейсмотектоническом отношении Приаральско-Каратауский сейсмоопасный регион, включающий территорию Южного Казахстана, изучен недостаточно. Вместе с тем для данного региона накоплены детальные геолого-геофизические материалы, а также данные о мощности земной коры и строении активной мантии. На этой территории в разные периоды фиксировались сейсмические события магнитудой M = 2.5–7.5, что свидетельствует о наличии потенциально опасных сейсмогенерирующих зон, способных порождать землетрясения высокой магнитуды. Эти зоны являются источниками мощных динамических воздействий на геологическую среду, а через неё, в свою очередь, — на строительные конструкции и среду обитания человека. Активность сейсмических районов определяется историей их геологического развития, особенно на неотектоническом этапе. На основе комплекса геофизических, геолого-тектонических и сейсмологических данных разработана региональная сейсмотектоническая модель — карта сейсмогенерирующих зон, отражающая реальные и потенциальные области возникновения очагов землетрясений. Сейсмотектоническая модель служит основой для расчётов сейсмической интенсивности в вероятностном варианте и прогноза сейсмических воздействий в терминах пиковых ускорений грунта. Карта тектонических разломов Южного Казахстана может использоваться при сейсмотектонических и геодинамических построениях, включая прикладные задачи прогнозирования опасных природных процессов, связанных с деструкцией земной коры. Совместно с базой данных она формирует фундамент для систематизации информации, её тектонофизического анализа и развития последующих картографических проектов, что способствует более глубокому пониманию особенностей сейсмотектонических процессов Южного Казахстана.

Ключевые слова: тектонический разлом, сейсмотектоническая модель, сейсмопотенциал

Introduction. Southern Kazakhstan is one of the developed industrial and agricultural regions of the Republic of Kazakhstan. Due to the peculiarities of natural conditions, all the most industrially developed and densely populated areas are located near potentially dangerous seismic zones with a maximum magnitude of expected earthquakes from 6 to 8, where industrial and civil construction is carried out and in connection with this there is an intensive growth of the population. Seismic zones are sources of powerful dynamic impacts on the geological environment, and through it - on various building structures and on the human habitat. On the other hand, it should be borne in mind that in some cases it is the level of seismic hazard of the territory that determines the prospects for further development of new industrial areas.

Urgent issues of ensuring population safety, earthquake-resistant construction and preventing possible damage from earthquakes have determined the need to develop a system of complex geological-geophysical and seismological study of geodynamically unstable zones. The zones are distinguished by the properties of the environment and the dynamics of processes that tend to destabilize them under the influence of regional and global forces, and are manifested in seismicity.

An important, essentially fundamental, seismogenic role is attributed to mobile fault zones. Active faults of various morphokinematic types, along with the presence of an active mantle, play a key role in controlling the seismicity of the study region (Timush, 2011). They are the most important deformation structural elements of the earth's crust, form regularly oriented systems, the study of which creates the prerequisites for identifying structural criteria for localizing earthquake focus (Myasnikov et al., 1981) and, on their basis, developing a seismotectonic model (maps of seismogenic zones).

One of the key problems of seismic hazard assessment and study of seismotectonic process patterns is related to the lack of electronic cartographic projects implemented at a modern scientific level using new information technologies (Lunina et al., 2010). Digital maps of tectonic faults with an accompanying attribute base in electronic form can be used as a tectonic basis for generalizing geological, geophysical, hydrogeological data for the purpose of forecasting dangerous endogenous geological processes, primarily seismic ones. Their advantage is a comprehensive basis that combines a large amount of data into a single format. As a basis for the seismotectonic model of Southern Kazakhstan A digital (electronic) map of active tectonic faults and an attribute database used in calculations for probabilistic assessment of seismic hazard have been developed.

Methodology for mapping tectonic faults using GIS technologies. Modeling of geographic space has simplified the implementation of geographic information systems (GIS) due to a fundamentally new approach to processing and presenting results in the format of digital models. GIS technologies allow for the generalization of huge arrays of information, on the basis of which an attribute database of the objects under study is created. In addition, geographic information systems are effective for determining the tectonic regime of an area, its dynamic potential and geological structure as a whole. An absolute advantage of digital maps is the ability to supplement new information according to selected criteria and expand the scope of the project when accumulating new data.

The map of active tectonic faults of South Kazakhstan is organized in the coordinate system of the Gauss-Kruger projection, units of measurement are meters, which allows for automatic calculation of the geographic characteristics of the fault: object coordinates, length, strike azimuth. When vectorizing faults, the scales of raster materials were taken into account, and faults were detailed. The work was carried out in the Arc GIS system.

A large number of archive and literary materials, as well as geological, tectonic, hydrogeological, cosmostructural and other maps of Kazakhstan and adjacent territories published in previous years, were collected, analyzed, critically assessed and summarized. The algorithm for creating a digital fault map includes referencing, digitizing (vectorizing) raster media and filling the attribute database with characteristics of faults, including the most complete information about them, separating faults by layers and map types. Detailing of faults provides for work on changing the position of already existing vector objects and their segmentation, if new sources indicate this. In this case, the rule of topological correctness and scaling is observed. In addition to thematic map layers, technical layers are created (geographical raster anchor points, cartographic benchmarks for linking the map to a specific coordinate system, etc.). In GIS, objects are depicted in vector form and linked to records of various information in attribute data bases.

In the course of the work, faults are segmented based on the change in geographic extent. This affected the filling of the attribute database, as in literary and field sources the fault is described completely, i.e. the characteristics of one segment are distributed by analogy to the entire length of this fault. In a particular case, in the attribute database, the segments of one fault have the same characteristics, but as the interpretation of new seismic data and analysis of space images shows, This does not always correspond to the actual characteristics of the fault segment.

The faults whose activity is confirmed by modern seismicity were studied. The geometry of the faults and their segments was determined by the coordinates of the nodes of their lines in the shape layer created as a result of vectorization of paper maps or conversion from databases of sources (with subsequent correction of their position according to contextual materials).

As a result of the analysis and generalization of the collected data at a modern level using GIS technologies (Arc GIS program [ArcGIS 10.4 for Desktop, license type: Basic]), a vector digital map of active faults of South Kazakhstan was developed (Figure 1).

The attribute database (Table 1) contains parameters for geographically linked objects (faults and their segments) with signs of the latest movements in the Late Pleistocene and Holocene: their names, segmentation, length of segments and their geographical coordinates, data on kinematics (direction of movements), strike azimuth, dip angle, movement velocities, estimated magnitude Mw. The database makes it possible to obtain information on faults and solve more general problems – thematic mapping, determining the parameters of modern geodynamic processes, assessing seismic and other geodynamic hazards. The format of the database construction allows for its constant replenishment.

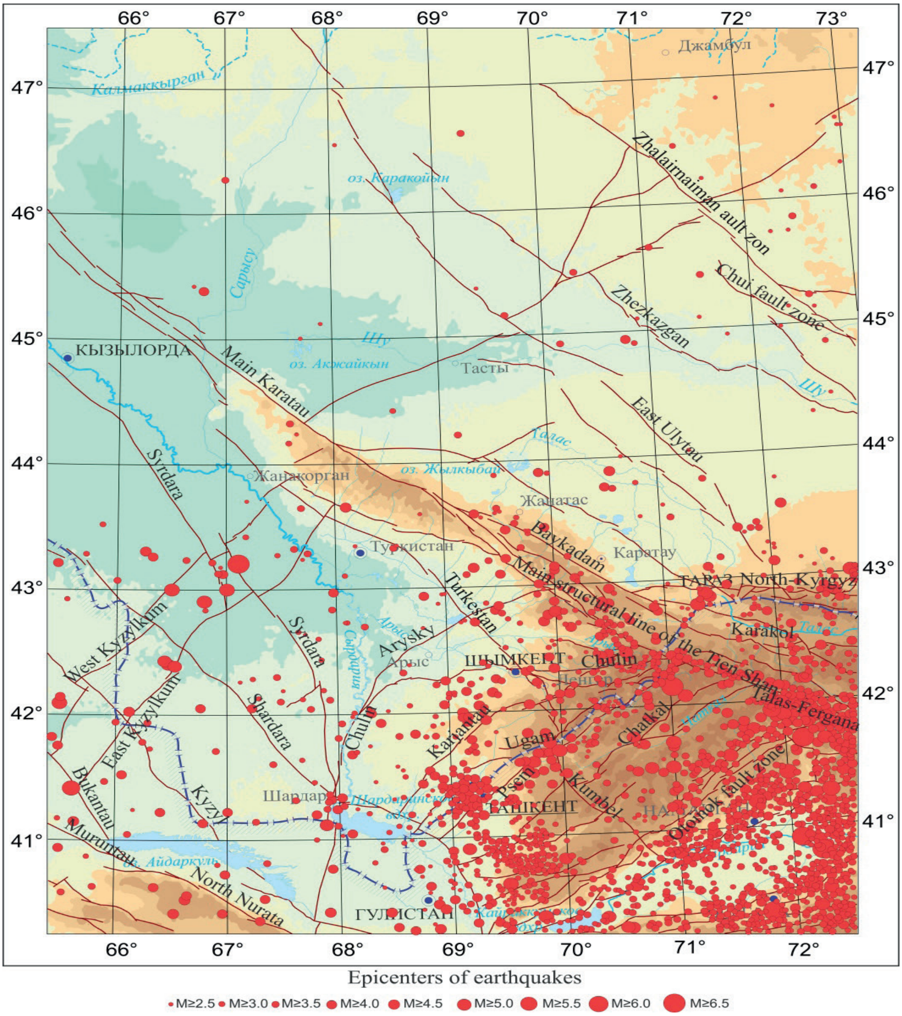

Figure 1. Map of active tectonic faults in Southern Kazakhstan

The calculation of the moment magnitude Mw was carried out using the formulas (Donald et al. 1994; Kocharyan, 2016)

1) Mw =5.08+1.16*log(Lmax), (for all faults),

where Lmax is the length of the fracture.

Used for faults with unknown type of movement.

2) Mw =5.16+1.12*log(Lmax) (for strike-slip)

For shifts: strike-slip.

3) Mw =5.00+1.22*log(Lmax) (for reverse faults),

For upthrusts, thrusts: reverse.

4) Mw =4.86+1.32*log(Lmax) (for normal faults),

For resets: normal.

Table 1. Attributive database of active tectonic faults of Southern Kazakhstan (fragment)

OBJECT ID #	ID No.	NAME	TYPE	SIDE	DIP	RATE	*Mw*
1	1_1	The main structural line of the Tien Shan	Strike slip	+SW	90°	1-3mm/year	6.57
2	1_2	The main structural line of the Tien Shan	Strike slip	+SW	90°	1-3 mm / year	6 . 5
…	…	…	…	…	…	…	…
1327	3_28	Talas-Fergana	R everse	+NE	70-85°	~2mm/year	5.52
…	…	…	…	…	…	…	…
1377	3_78	Main Karatau	Reverse	+N	50-65°	~2mm/year	5.49
…	…	…	…	…	…	…	…
2231	8_1	Chulin	No data	+E	No data	No data	6
…	…	…	…	…	…	…	…
2257	8_27	Chulin	Thrust	+S	~35°	No data	5 . 98
…	…	…	…	…	…	…	…
2490	14_133	Syrdara	Normal	+NW	75-90º	1.5-2.4 mm / year	5.47
2491	14_132	Syrdara	Normal	+NW	75-90º	1.5-2.4 mm/ year	5.4
…	…	…	…	…	…	…	…

Continuation of table 1

BEARING	minX	minY	maxX	maxY	SHAPE_Length
290.3	70.940922	42.426883	70.744521	42.496502	18100.5
261	70,731466	42,478254	70.545283	42.46905	15589.3
	…	…	…	…	…
285	68.998551	43.383505	68.968068	43.391204	2641.9
	…	…	…	…	…
333.2	67.337662	43.89081	67.325128	43.911388	2498.9
…	…	…	…	…	…
355.3	67.894827	41.144019	67.892964	41.200011	6221.1
…	…	…	…	…	…
96.3	68.724904	42.26226	68.800894	42.252125	6394.2
…	…	…	…	…	…
33 6 .2	66.090164	44.239028	66.082616	44.252717	1637.45
331.7	66.060039	44.283431	66.049151	44.299354	1972.66
…	…	…	…	…	…

OBJECT ID – object identifier, NAME – name; TYPE – type, fault kinematics; SIDE – dip azimuth relative to the raised wing; DIP – dip angle; RAT – velocity of movement within the geological structure; *Mw* – estimated moment magnitude; BEARING – strike azimuth; minX ; Y– initial coordinates of the fault segment; maxX , Y– final coordinates of the fault segment, SHAPE Length – the length of this segment.

Research results and discussion. Based on a complex of geophysical, geological and tectonic features of the deep and upper crustal structure of the earth's crust, seismological data A regional seismotectonic model (Map of seismogenic zones) of real and potential zones of occurrence of earthquake sources in the territory of Southern Kazakhstan was developed (Figure 2).

The established seismological, geological and geophysical criteria served as the basis for differentiating seismogenic zones by the maximum magnitude of expected earthquakes (Timush et al., 2012). A brief description of the most important of them is given.

North Kyrgyz seismogenic zone is confined to the marginal reverse -thrust fault, limiting the Kyrgyz Range from the north. In the blocks adjacent to the zone, pre-Baikal and Baikal metamorphic complexes are exposed, penetrated on the eastern flank by the Kungey granite massifs (Knauf, 1966). The thickness of the earth's crust increases from west to east from 50 to 60 km. Along the described zone, the magnitude of the displacement of the Epihercynian Leveling Surface increases from west to east from 1.5 to 7.5 km, and its total uplift in the Kyrgyz Range is, respectively, 1.5-4.0 km. The total INM (intensity of neotectonic movements), therefore, fluctuates from 3 to 11.5 units, which allows us to estimate the seismogenic potential of the North Kyrgyz zone from M_{max} = 6.5 to 7.0. To date, the largest earthquake in the zone had a magnitude of M = 6.5 (Sydykov, 2004).

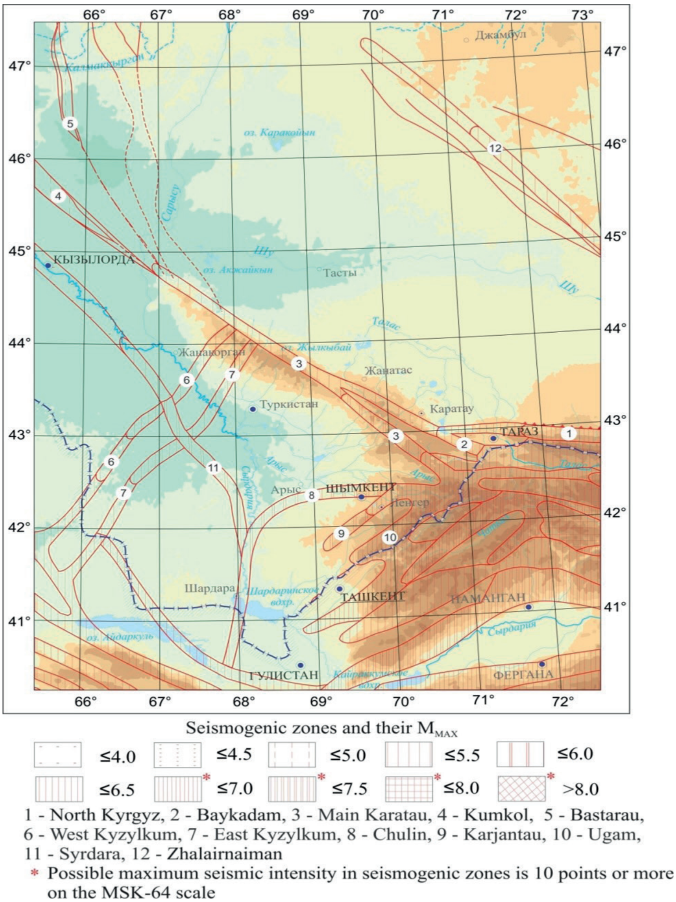

Figure 2. Map of seismic generating zones of Southern Kazakhstan

Baikadam seismogenic zone corresponds to the dynamic zone the fault of the same name, dividing the Proterozoic and Lower Paleozoic blocks of the Maly Karatau. The structural-material complexes are represented by terrigenous rocks metamorphosed to varying degrees; granitoid intrusions are absent. The amplitudes of the latest movements do not exceed 400 м. The seismicity of this region is characterized by earthquakes of the class K= 9-11 with focal depths within 15- 20 km. In general, the seismic potential The Baikadam zone is estimated as M_{max}= 5.5.

Main Karatau seismogenic zone is associated with a deep fault, which is the main structural element of this region on the continuation of the Talas-Fergana fault. Of all the faults, the Main Karatau Fault is the best studied. It has been traced by seismic exploration to a depth of over 60 km (i.e. it is a through-crust fault), and the amplitude of the vertical displacement of the northeastern wing reaches 8- 19 km (Abdulin et al., 1986). According to the kinematics of movements, the fault is a through right-hand strike-slip fault of long development (from the Upper Proterozoic to the present), separating various geotectonic structures: to the northeast of it are early Caledonian complexes, and to the southwest are middle Hercynian complexes with Caledonides at the base; the consolidated base is characterized by the absence of intrusive massifs (Ibragimov, 1978).

In the newest tectonic structure of the Main Karatau the fault is also clearly expressed, delimiting the wings of the Karatau arch, the strike of which coincides with the orientation of the main Hercynian structures. The southwestern wing along the described zone is thrown up, and the amplitude first increases from northwest to southeast to 2000 m, and then decreases to 600-700 m. The heights of the peneplain in the same direction accordingly increase from 800 m to 2500 m, and then decrease to 600 m. In the Aryskum depression, a number of subparallel faults extending to the north can be attributed to the zone of influence of the Main Karatau fault, forming graben-like structures with a vertical displacement of up to 1500-2000 m. Taking into account the given characteristics, the seismogenic potential of the Main Karatau zone is assessed differential. In the area of maximum intensity of the newest movements M = 6.0, and to the northwest of it M = 5.5. To date, strong earthquakes are not known in the Karatau region, seismic activity and K_{max} are not assessed due to the lack of instrumental data.

The West and East Kyzylkum seismogenic zones are confined to the faults of the same name, identified under the platform cover along the northwestern edge of the Zhaugash depression, which apparently has a graben morphology. In the western part of the Aral-Karatau seismically active region, the faults are considered active. The relative displacement along the northwestern edge of the named structure is about 1 km. In the Quaternary, this block has a tendency to rise. The consolidated basement is represented by terrigenous Caledonian formations. The crustal thickness is increased to according to instrumental observations, earthquakes with 48 km K = 9-15 occurred within the Kyzylkum zone . The seismic potential of the zone is estimated as M_{max}= 6.5 to the southwest of the intersection with the Syrdarya zone and as M_{max}= 5.5 to the northeast of this node (Timush et al., 2012).

Chulinskaya seismogenic zone accompanies a fault that arcs across a vast area of the newest Chatkal-Kurama uplifts located to the south of it. The fault zone in the consolidated basement is expressed by intensive crushing, secondary changes in carbonate-terrigenous formations; a step with a displacement amplitude of about 1.5 km is noted along the fault. Within the Chatkal-Kurama mountain region (Timush, 2011; Khodjaev, 1985), the most widely developed and clearly expressed in both Paleozoic and Mesozoic-Cenozoic deposits are the NE fault systems, which are the boundary between the latest uplifts and subsidences (Tashkent, 1971). Almost all structures of the mountain region adjoin the end of the Talas -Fergana fault and have a SE asymmetry (Chediya, 1986; Nurmatov et al., 2004). The age of the faults is Upper Paleozoic, most of the faults appeared between the Middle Carboniferous and Late Permian. These fault systems are still active in the modern period. According to morphogenetic features, they are represented by reverse faults, thrusts, and, less often, normal faults. The amplitude of vertical displacement along some faults reaches 5- 6 km. High intensity of recent movements is also noted here, which makes it possible to predict earthquakes with a magnitude of up to 6.0, and perhaps even more. The thickness of the earth's crust is about 40 km. According to available instrumental data, numerous earthquakes of the class have occurred along the Chulin zone K = 9-12.

Karzhantau seismogenic zone is associated with a series of updated faults that limit the northwest Karzhantau rising block. Karzhantau the rift is one from most extended bursting violations north - east directions. Almost on to all throughout it is clear is fixed geomorphologically and fine celebrated on topographic maps . Surface mixer tilted on northwest under angle from 40º to 70º. Maximum vertical amplitude movements by break exceeded 3000 m. Shifts by him continued and in quaternary time that is fixed moving deposits Karzhantau terraces up to 100 m (Chediya, 1986). Landslides, avalanches and earthquakes timedto zone fault, serve confirmation his modern activity. Seismic activity zones marked more to Tashkent earthquake of April 26, 1966, epicenter whom was timed to her. Her north-west wing raised. Amplitude movements for newest stage reaches 3500 m (Maksudov et al., 2005). The total value of the vertical neotectonic movements of the Karzhantau arch-block uplift is emphasized by the values of mean velocity gradients of 0.2-0.4 mm/year. According to the complex of geological parameters, the seismogenic potential of the zone is estimated as M_{max}=7.0 with a decrease to 6.5 on the southwestern extension. The maximum earthquake in the zone had a magnitude of M = 6.5.

The Ugam seismogenerating zone is associated with block uplifts of the Pskem and Ugam ridges, located in the area of influence of the Kumbel-Ugam fault zone, which have maximum values of gradients of average velocities of the latest vertical tectonic movements of 0.4-0.7 mm/year. Ugam zone faults is northwestcontinuation Kumbel and can be traced from Humsan on north - northwest, cuttingwatershed Karzhantau ridge and fading away upper reaches r. Keles under quaternary deposits.

Morphologically expressed reset, value vertical movements by to whom is not the same (Zubovich et al., 2004).

The Chatkal block, which is complexly constructed and extends westward beyond the above-mentioned zone, is distinguished by a mosaic distribution of sections with gradients of average velocities of recent vertical movements, the highest values of which reach 0.3-0.9 mm/year. The modern seismic activity of the fault zone is confirmed by the active manifestation of physical and geological processes within its boundaries, as well as by the confinement of earthquakes. There are also paleoseismic structures here that were formed during paleoearthquakes with a strength of at least 9 points (Khodjaev, 1985; Bakiev et al., 2001). However, an analysis of the history of the development of these faults has shown that they were active in the Cenozoic period. Detailed seismogeological and geodynamic studies indicate the activation of modern tectonic movements in this zone. Using paleoseismological data, more accurate information was obtained from pleistoseismic and possibly epicentral zones of strong earthquakes and the highest level of seismic hazard of the Kumbel- Ugam fault zone was identified. In addition, seismic events up to the twelfth energy class were noted in the fault zone. The maximum width of the influence zone of the Kumbel- Ugam faults reaches 25 km.

The Syrdarya seismogenic zone is confined to the fault of the same name, identified by geophysical and remote sensing methods along the southwestern foothills of the Karatau Range beneath the Cretaceous-Quaternary cover (10 to 300 m thick) in the Epi-Caledonian basement. It runs from SE to NW at an azimuth of 315º; it is almost rectilinear, and is a normal fault with the fault plane dipping to the SW at an angle of 75-90º. (Ospanov et al., 1974). Throughout the Upper Paleozoic, the fault played a decisive role in the formation of faults, magmatism, and metallogeny. The fault was formed in the Middle Carboniferous as a result of increased tectonic movements; After the Middle Carboniferous period, the Syr Darya fault, crossing the edge of the folded structure, was the boundary between the anticlinorium of the North-West Karatau and the Kyzylkum depression and during the late Hercynian stage had great mobility and permeability. A three-phase intrusive complex is spatially and temporally associated with the Syr Darya fault: the first phase is represented by ultrabasic rocks (Middle Carboniferous), serpentinized, then reworked into talc shales, the second phase is diorites and the third is granites (Late Carboniferous). The consolidated basement is represented by carbonate-terrigenous formations, the thickness of the earth's crust is about 40 km. The vertical amplitude of the Syr Darya deep fault is established in the Karamurun Mountains and is 1000-1500 m. The intensity of Alpine movements is from 0.6 to 1.2 km, and the total subsidence is from 0.8 to 2.4 km. The total intensity of the newest movements in individual small areas reaches 3.8 km, but its values predominate at 2.8-3.0 km, typical for areas with a magnitude of M = 6.0 (Timush, 2011). This seismic potential is predicted for the entire Syr Darya zone, within which such events took place. On the northwestern flank, after crossing the Kyzylkum zone, the amplitudes of basement displacements do not exceed 0.2 km, but the zone is still traced by weak earthquakes. Here its potential is estimated as M_{max} = 5.5.

Zhalairnaimanskaya The seismogenic zone is mapped along the fault, which is a long-lived upthrust -slip fault dipping to the northeast at angles of 70-80°: it is traced over more than 1000 km, controlled by the ultramafic belt. The fault was laid in the Baikal epoch of tectogenesis and has been repeatedly renewed. Along it, due to vertical folded -block movements in the crushing zone up to5 km a tectonic mélange was formed, consisting of rocks of different ages and compositions (hyperbasites, gabbroids, diabasites, spilites, siliceous-clayey shales, limestones). It continues into the Tien Shan, where it is most clearly expressed on the northern slope of the Kungei Alatau in the form of tectonic scarps and river valleys of NW strike. The amplitudes of the latest movements do not exceed 200 m (Timush, 2011; Timush et al., 2012). Seismicity is characterized by rare weak earthquakes of the class K = 7-8 with focal depths of 15- 20 км. Seismic potential The Zhalairnaiman zone is estimated at M_{max} = 4.5.

Conclusions. As a result of the conducted research, a vector digital map of active tectonic faults of Southern Kazakhstan was developed using GIS technologies. Active faults of various morphokinematic types play a key role in monitoring seismicity in the region and are the most important deformation structural elements of the earth's crust when identifying criteria for localizing earthquake foci. The attributive database of faults can be used to solve such problems as thematic mapping, determining the parameters of modern geodynamic processes, assessing seismic and other geodynamic hazards. The format of the database construction allows for its constant replenishment.

The creation of a seismotectonic model in the form of a map of seismogenic zones differentiated by the maximum magnitude of expected earthquakes is a general problem of assessing seismic hazard and seismic risk of territories, which is very important for planning the economic development of sectors of the national economy and the construction of residential agglomerations. In this aspect, it is necessary to continue searching for fundamental connections between seismicity parameters and geological conditions, tectonic structure, deep structure of the earth's crust, the latest tectonic movements and geophysical fields.

References

Abdulin A.A., Chimbulatov M.A., Ergaliev G.Kh. and others. (1986) Osnovnye cherty geologicheskogo stroeniya i rayonirovanie Karatau [Main features of the geological structure and zoning of Karatau]. Geology and metallogeny of Karatau. - Alma-Ata: Science. — P. 5-8. (in Russ)

Bakiev M.Kh., Khamidov L.A., Ibragimov A.Kh. (2001) Koncentraciya napryazheniy vblizi lokalnyh neodnorodnostey zemnoy kory [Stress concentration near local inhomogeneities of the earth's crust]. Inland Earth quake. China, 2001. — Vol. 15, No. 4. — P. 376-384. (in Russ)

Bakiev M.Kh., Khamidov L.A. (2001) Izmenenie peremeshcheniy na poverhnosti epicentralnoy zony [Changes in displacements on the surface of the epicentral zone]. Inland Earthquake. China, 2001. — Vol. 15, No. 3. — P. 259-267. (in Russ)

G.G. Kocharyan. Geomekhanika razlomov [Geomechanics of faults]; Russian Academy of Sciences; Institute of Geosphere Dynamics; Russian Science Foundation, M.: GEOS, 2016. — 424 p. (in Russ)

Donald L.W, Kevin J. Coppersmith. Novye empiricheskie sootnosheniya mezhdu magnitudoy, dlinoy razryva, shirinoi razryva, ploshchadyu razryva i smeshcheniem poverhnosti [New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement]. Bulletin of the Seismological Society of America 1994; 84(4):974–1002. doi: https://doi.org/10.1785/BSSA0840040974 (in Russ)

Zubovich A.V., Yarmukhamedov A.R., Kuzikov S.I., Moisenko O.I., Radzhabov Sh.S., Shchelochkov G.G. (2004) Sovremennye deformacionnye processy v zapadnom Tyan-Shane [Modern deformation processes in the western Tien Shan]. Problems of seismic hazard assessment, seismic risk and earthquake forecast. — Tashkent, 2004. — P. 238-240. (in Russ)

Ibragimov R.N. (1978) Seysmogennye zony Srednego Tyan-Shanya [Seismogenic zones of the Middle Tien Shan]. — Tashkent. — 144 p. (in Russ)

Knauf V.I. (1966) Tektonicheskoe rayonirovanie Severnoy Kirgizii [Tectonic zoning of Northern Kyrgyzstan]. Geotectonics. — No. 5. — P. 48-57. (in Russ)

Lunina O.V., Gladkov A.S., Sherstyankin P.P. Novaya elektronnaya karta aktivnyh razlomov yuga Vostochnoy Sibiri 2010 g [New electronic map of active faults in the south of Eastern Siberia in 2010]. Reports of the Academy of Sciences, 2010, Vol. 433, No. 5. - P. 1-6. (in Russ)

Myasnikov A.K., Bykadorov V.A., Michman E.S., Smirnov A.V., Kovrizhnykh Yu.B. (1981) Nalozhennye progiby i vpadiny [Superimposed troughs and depressions]. Geological map of the Kazakh SSR. South Kazakhstan series (explanatory note), - Alma-Ata. — P. 229-238. (in Russ)

Maksudov S.Kh., Pak V.A., Voronich T.M., Karimova G.G., Bisenova A.T. Nekotorye osobennosti stroeniya i geodinamiki litosfery Uzbekistana i ih svyaz s metallogeniey [Some features of the structure and geodynamics of the lithosphere of Uzbekistan and their relationship with metallogeny]. Zhurn. Geology and mineral resources, 2005. — No. 2. — P. 48-52. (in Russ)

Nurmatov U.A., Ibragimov R.N. Dinamika seysmichnosti v seysmogennyh zonah Uzbekistana [Dynamics of seismicity in seismogenic zones of Uzbekistan]. Problems of seismic hazard assessment, seismic risk and earthquake forecast. - Tashkent, 2004. — P. 224-233. (in Russ)

Ospanov E.S., Valeev F.Ya. (1974) Nekotorye dannye o prirode Syrdaryinskogo razloma v yugo-zapadnyh predgoryah severnogo Karatau [Some data on the nature of the Syr Darya fault in the southwestern foothills of northern Karatau]. Materials on the geology and mineral resources of Southern Kazakhstan. — Alma-Ata, 1974. — P. 199-203. (in Russ)

Sydykov A. (2004) Seysmicheskiy rezhim territorii Kazahstana [Seismic regime of the territory of Kazakhstan]. — Almaty: Gylym. — 270 p. (in Russ)

Gl. ed. G.A. (1971) Mavlyanov, Tashkentskoe zemletryasenie [Tashkent earthquake]. — Tashkent. — 672 p. (in Russ)

Timush A.V., Taradaeva T.V., Stepanenko N.P., Sadykova A.B., Sydykov A. (2012) Seysmogeneriruyushchie zony Kazahstana [Seismogenic zones of Kazakhstan] - Almaty. — 81 p. (in Russ)

Timush A.V. (2011) Seysmotektonika litosfery Kazahstana [Seismotectonics of the lithosphere of Kazakhstan] - Almaty: Luxe Media Group. — 590 p. (in Russ)

Khodjaev A.K. (1985) Paleoseysmogeologiya Chatkalo-Kuraminskogo regiona [Paleoseismogeology Chatkal-Kurama region]. — Tashkent: Fan. — 136 p. (in Russ)

Chedia O.K. (1986) Morfostruktury i noveyshiy tektogenez Tyan-Shanya [Morphostructures and the newest Tectogenesis of Tien Shan]. — Frunze: Ilim. — 314 p. (in Russ)

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