ISSN 2518-170X (Online)
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ

Satbayev University

ХАБАРЛАРЫ

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
НАУК РЕСПУБЛИКИ
КАЗАХСТАН
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N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF
KAZAKHSTAN
Satbayev University

SERIES

OF GEOLOGY AND TECHNICAL SCIENCES

5 (455)

SEPTEMBER – OCTOBER 2022

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

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«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген **№ KZ39VPY00025420** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *геология, мұнай және газды өңдеудің химиялық технологиялары, мұнай химиясы, металдарды алу және олардың қосындыларының технологиясы.*

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19
http://www.geolog-technical.kz/index.php/en/

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Мұратбаев көш., 75.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан **№ KZ39VPY00025420,** выданное 29.07.2020 г.

Тематическая направленность: *геология, химические технологии переработки нефти и газа, нефтехимия, технологии извлечения металлов и их соеденений.*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19

http://www.geolog-technical.kz/index.php/en/

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).
The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ39VPY00025420,** issued 29.07.2020.
Thematic scope: *geology, chemical technologies for oil and gas processing, petrochemistry, technologies for extracting metals and their connections.*
Periodicity: 6 times a year.
Circulation: 300 copies.
Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19
http://www.geolog-technical.kz/index.php/en/

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

NEWS of the National Academy of Sciences of the Republic of Kazakhstan
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
https://doi.org/10.32014/2518-170X.230

UDC 911.52

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GEOLOGICAL STATE OF THE STRATIGRAPHIC COMPLEX OF THE TENGIZ DEPOSIT

Abstract. The article evaluates the engineering and geological conditions geological state of the stratigraphic complex of the Tengiz deposit. The conducted studies show the most complete, reliable and accessible information about the geological structure; engineering-geological sections were compiled with the differentiation of the geological environment into stratigraphic and genetic complexes and their constituent lithological and facies groups (engineering-geological elements - EGE). Complex data processing made it possible to determine the degree of facies heterogeneity of the main lithological and facies groups of soils. The studied territory is part of the Zhylyoysky district of the Atyrau region of the Republic of Kazakhstan and is located in the western part of the industrial zone of the Tengiz deposit. The soils formed as a result of the natural-historical process of the formation of the territory are divided into 3 stratigraphic-genetic complexes of unlicensed deposits. The first complex is represented by loamy silt (EGE-1), the second complex is sandy loam (EGE-2) and light powdery clay (EGE-3) and the third complex is represented by four deposits - Light arenaceous loam, excessively gypsumized (EGE-4), Arenaceous sandy loam (EGE-5), Light arenaceous loam, slightly gypsumized (EGE-6), Light arenaceous clay, moderately gypsumized (EGE-7). Highly aggressive to sulfates are Portland cement asper GOST 10178 grades W6, W8, W10-W14, W16-W20, W4; moderately and slightly aggressive Portland cement as per

GOST 10178 withpercentage of C_3S not more than 65%, C_3A not more than 7%, $C_3A + C_4AF$ not more than 22% and blast-furnace cement's grade of W6 and W8. Highly aggressive to chlorides are all of grades of Portland cement

Key words: Tengiz deposit, engineering-geological elements, stratigraphic complex, highly aggressive, sulfates, chlorides.

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ТЕҢІЗ КЕН ОРНЫНЫҢ СТРАТИГРАФИЯЛЫҚ КЕШЕНІНІҢ ГЕОЛОГИЯЛЫҚ ЖАҒДАЙЫ

Аннотация. Мақалада Теңіз кен орнының стратиграфиялық кешенінің геологиялық жағдайының инженерлік-геологиялық күйіне баға берілген. Жүргізілген зерттеулер геологиялық құрылым туралы неғұрлым толық, сенімді және қолжетімді ақпаратты көрсетеді; инженерлік-геологиялық қималар геологиялық ортаны стратиграфиялық кешендерге және оларды құрайтын литологиялық және фациалдық топтарды (инженерлік-геологиялық элементтер - ИГЭ) саралау арқылы жасалды. Деректерді кешенді өңдеу топырақтың негізгі литологиялық және фазалық топтарының фазалық гетерогенділігінің дәрежесін анықтауға мүмкіндік берді. Зерттелетін аумақ Қазақстан Республикасы Атырау облысы Жылыой ауданының құрамына енеді және Теңіз кен орны өнеркәсіптік аймағының батыс бөлігінде орналасқан. Аумақтың қалыптасуының табиғи-тарихи процесі нәтижесінде пайда болған топырақ лицензияланбаған кен орындарының 3 стратиграфиялық кешеніне бөлінген. Бірінші кешен сазды тұнбамен (ИГЭ-1), екінші кешен - құмды саздақпен (ИГЭ-2) және жеңіл шаңды сазбен (ИГЭ-3), ал үшінші кешен төрт шөгінділермен ұсынылған: жеңіл, шамадан тыс гипстелген - саздауыт (ИГЭ-4), құмды саздауыт (ИГЭ-5), жеңіл құмды саздауыт (ИГЭ-6), жеңіл құмды саз, орташа гипс (ИГЭ-7). Сульфаттарға жоғары агрессивті W6, W8, W10-W14, W16-W20, W4 маркалы

ГОСТ 10178 сәйкес портландцемент болып табылады; құрамында C3S 65% - дан аспайтын, C3A 7% - дан аспайтын, C3A + C4AF 22% - дан аспайтын және W6 және W8 домендік цемент маркасы бар МЕМСТ 10178 бойынша орташа және әлсіз агрессивті портландцемент. Хлоридтерге жоғары агрессивті-портландцементтің барлық маркалары екендігі анықталды.

Түйін сөздер: теңіз кен орны, инженерлік-геологиялық элементтер, стратиграфиялық және генетикалық кешен, жоғары агрессивтілік, сульфаттар, хлоридтер.

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ГЕОЛОГИЧЕСКОЕ СОСТОЯНИЕ СТРАТИГРАФИЧЕСКОГО КОМПЛЕКСА ТЕНГИЗСКОГО МЕСТОРОЖДЕНИЯ

Аннотация. В статье дана оценка инженерно-геологических условий геологического состояния стратиграфического комплекса Тенгизского месторождения. Проведенные исследования показывают наиболее полную, достоверную и доступную информацию о геологическом строении; инженерно-геологические разрезы составлены с дифференциацией геологической среды на стратиграфические комплексы и составляющие их литологические и фациальные группы (инженерно-геологические элементы - ИГЭ). Комплексная обработка данных позволила определить степень фациальной неоднородности основных литологических и фациальных групп почв. Исследуемая территория входит в состав Жылыойского района Атырауской области Республики Казахстан и расположена в западной части промышленной зоны Тенгизского месторождения. Почвы, образовавшиеся в результате естественно-исторического процесса формирования территории, разделены на 3 стратиграфического комплекса месторождений. Первый комплекс представлен суглинистым илом (ИГЭ-1), второй комплекс - супесью песчанистой (ЭГЭ-2) и легкой пылеватой глиной (ЭГЭ-3), а третий комплекс представлен четырьмя отложениями

легкий, избыточно загипсованный - суглинок (ЭГЭ-4), песчанистая супесь (ЭГЭ-5), легкий песчанистый суглинок (ЭГЭ-6), легкая песчанистая глина, умеренно гипсованная (ЭГЭ-7). Высоко-агрессивным к сульфатам является портландцемент по ГОСТ 10178 марок W6, W8, W10-W14, W16-W20, W4; умеренно- и слабоагрессивный портландцемент по ГОСТ 10178 с содержанием C3S не более 65%, C3A не более 7%, C3A + C4AF не более 22% и маркой доменного цемента W6 и W8. Высоко-агрессивными к хлоридам являются все марки портландцемента.

Ключевыеслова: Тенгизскоеместорождение, инженерно-геологические элементы, стратиграфический комплекс, высокая агрессивность, сульфаты, хлориды.

Introduction. The investigated area is a part of Zhylyoi region of Atyrau oblast of Republic of Kazakhstan and located within the western part of Tengiz field Industrial Zone. “Tengizchevroil” Company is the owner of the area within Tengiz field. The district center, the town of Kulsary is located at the distance equal to 110km; it is reached by asphalt motor road and railroad connecting Kulsary and Tengiz field.

The regional center is Atyrau city located at a distance equal to 350km; it is reached by asphalt motor road and railroad, as well as by special air flights. Kulsary at the same time is the nearest railway station connecting Tengiz field Industrial zone with other regions of Kazakhstan.

As indicated in the works James Weber L. and etc. (James L. et al., 2003) the movement along the investigated territory is possible only by means of off-road transport and crawler vehicle. The climate of area is sharply continental, arid. The continentality and aridity of climate are manifested in sharp temperature contrasts of day and night, winter and summer and shortspring period between winter and summer (Collins J. et al., 2014). The special feature of climate is variability and deficiency of atmospheric precipitations, insignificant snow and intense snow blowing, high dryness of air and soil, intensity of evaporation process and abundance of direct sunlight. The winter is cold, but; short-term; the summer is hot and rather continuous. The close proximityof the Caspian Sea eastern coast virtually does not have a damping effect on climate of area.

One of the features of the Peri-Caspian basin is that it is a vast area of deeply immersed crystalline basement on south-east of the Russian platform which is a big tectonic depression differing from other part of the platform by sedimentary deposits large thickness and development of salt-dome structures in the core of which a thick salt-bearing mass of Kungur Age occurs (Chakabayev S.Ye. et al., 1979).

This mass possesses a significant plastic property and unusual mobility

and under the influence of Mesozoic and Cenozoic rocks at rest pressure, it rises slightly and transects the overlying rocks creating the peculiar salt-dome structures (Yang L. et al., 2019). The largest part of these structures is embedded under the Pliocene-and-Quaternary sediments, and only singular dome folds are opened up; the salt core on them crops out on the ground surface or is overlapped by insignificant quaternary (Pleistocene and Holocene) sediments strata.

The salt-dome structures have a significant impact on formation of ground water chemical composition (degree of salinity), salinity level and nature of the Pliocene-Quarternary age soils (Hinojosa-Prieto Hector R. et al., 2021).

A very large number of studies have been devoted to the issue of the aggressive effect of chloride salts on steel reinforcement in foreign publications (Smolyago G.A. et al, 2014, Boltsoni F. et al., 2015, Leonovich S.N. et al., 2016, Ivannikov V.V. et al., 2015, Ratkin V.V. et al., 2015). The chemical aggressiveness of wet soils depends on the composition of the liquid, soluble salts, their concentration and filtration rate. In this case, the solution in the soil pores will be aggressive, and therefore the destruction of building structures will proceed according to the mechanism of their destruction processes in liquid media. The values of the aggressiveness of the liquid medium for concrete of various grades for water resistance and the classification of soil aggressiveness are given in Table 1.

Table 1 - Classification of soils by aggressiveness (GOST 31384-2008)

Humidity zone (according to SNiP 23-02-2003)	Aggressiveness index, mg per 1 kg				The degree of aggressive impact on concrete and reinforced concrete structures
	of sulphate soil in terms of SO_4 for concrete on			chlorides in terms for concretes on Portland cement, slag-portland cement and sulfate-resistant cements	
	portland cement	Portland cement with a C4S content of no more than 65%. CAA no more than 7%, HPA + C4AF hc more than 22% and slag-portland cement	sulphate-resistant cements		
Dry	Over 500 to 1000	Over 3000 to 4000	Over 6000 to 12000	Over 400 to 750	Mildly aggressive
	Over 1000 to 1500	Over 4000 to 5000	Over 12 000 to 15000	Over 750 to 7500	Medium aggressive
	Over 1500	Over 5000	Over 15 000 0	Over 7500	Highly aggressive
Normal and wet	Over 250 to 500	Over 1500 to 3000	Over 3000 to 6000	Over 250 to 500	Mildly aggressive
	Over 500 to 1000	Over 3000 to 4000	Over 6000 to 8000	Over 500 to 5000	Medium aggressive
	Over 1000	Over 4000	Over 8000	Over 5000	Very aggressive

Indicators of aggressiveness but chloride content are given only for reinforced concrete structures made of concrete of the W4-W6 waterproof grade. With the

simultaneous content of sulfates, their amount is recalculated by the chloride content multiplied by 0.25 and summed with the chloride content.

According to the European standards EN 206. "Concrene – Part 1: Specification, performance, production and conformity", the maximum permissible amount of chlorides per Cl–ions should not exceed 0.4% of the cement mass in concrete of reinforced concrete structures and 0.1% in concrete of pre-woven reinforced concrete structures.

Materials and methods. The drilling of engineering-geological wells was carried out using a drilling rig on an all-terrain vehicle "ARDCO" (Country of manufacture - USA). The drilling of wells was accompanied by casing pipes. Drilling diameter up to 108 mm.

In the process of drilling engineering-geological wells, soil samples of undisturbed structure (monoliths) were selected using a driven (crushed) GC-123 soil carrier. All selected soil samples of undisturbed structure (monoliths) were packed and decorated in accordance with the requirements of GOST 12071-2014 "Soils. Sampling, packaging, transportation and storage of samples". Monoliths are protected from extreme temperatures, direct sunlight, moisture and frost.

Samples of the disturbed structure were taken from sandy soils using a standard penetration primer (Automatic drop hammer SPT), during the production of dynamic sensing. They were stored in sealed plastic bags and were used to classify soils, determine indicators of physical properties of soils and chemical tests.

The number, coordinates, marks, depths of engineering-geological wells and the total number of soil samples of disturbed and undisturbed structures, as well as ground water, are presented below in the form of a table 2.

Table 2 - The number, coordinates, marks, depths of engineering-geological wells and the total number of soil samples

N	Number of wells	Coordinates of wells		Wellhead marks, m Well depth, m	Wellhead marks, m Well depth, m	Soil sampling			Sampling of ground water
		E	N			Undisturbed Violated (SPT)	Total number	Undisturbed Violated (SPT)	
1	B48-1-04	684626.08	5102679.06	-26.47	10.0	11	12	23	1
2	B48-1-07	684625.96	5102553.91	-26.53	20.0	7	16	23	1
3	B48-1-08	684826.02	5102553.97	-26.51	20.0	11	11	22	-
4	B48-1-11	684826.01	5102429.00	-26.51	20.0	11	11	22	1
5	B48-1-12	685026.04	5102428.97	-26.51	20.0	10	13	23	1
6	B48-1-15	685025.92	5102303.89	-26.46	20.0	10	13	23	1

N	Number of wells	Coordinates of wells		Wellhead marks, m Well depth, m	Wellhead marks, m Well depth, m	Soil sampling			Sampling of ground water
		E	N			Undisturbed Violated (SPT)	Total number	Undisturbed Violated (SPT)	
TOTAL	6 WELLS				110.0	60	76	136	5

Level measurements and groundwater sampling were carried out in all open boreholes 24 hours after the completion of drilling and pumping of surface water from the well. The values shown in the columns of engineering-geological wells are those values that were measured after 24 hours.

Measurements of the steady-state groundwater level (UGV) and sampling of groundwater were carried out using the PE-1220 sampling device.

Drilling of engineering-geological wells was carried out in the period from 30.11.2021 to 08.12.2021.

Determination of the content of sulfate and chloride ions was carried out in the geotechnical laboratory of JSC "NIPI "Kaspiymunaygas", according to the following methods: GOST 26426-85. "Soil. Methods for determining the sulfate ion in an aqueous extract" and GOST 26425-85. "Soil. Methods for the determination of chloride ion in an aqueous extract".

The statistical processing of obtained and collected information is, first of all, based on the Interstate standard "GOST 20522-2012. Soils. Test results statistical processing methods"requirements, and also other fundamental State and Interstate regulations and legislative instruments (Muzylev N.G. et al., 19996).

As a result of which an information concerning area physiographic conditions, geological structure, hydrogeological conditions and seismicity were obtained in the fullest possible, fairand available manner; geotechnical cross-sections with differentiation of geological environment into stratigraphic and genetic complexes and their component lithological and facies groups (engineering geological elements - EGE) were constructed; calculations for determining soil physical, mechanical and chemical properties and groundwater chemical quality were calculated. It is important to note that an integrated processing of all available above mentioned data allowed determining the degree of facial inhomogeneity of main lithological and facies groups of soils, i.e. marker horizons, both by the lithology and by the degree of density (Seitov N. et al., 2021).

Results. The investigated area is a part of Zhylyoi region of Atyrau oblast of Republic of Kazakhstan and located within the western part of Tengiz field

Industrial Zone. "Tengizchevroil" Company is the owner of the area within Tengiz field. The district center, the town of Kulsary is located at the distance equal to 110km; it is reached by asphalt motor road and railroad connecting Kulsary and Tengiz field. The regional center is Atyrau city located at a distance equal to 350km; it is reached by asphalt motor road and railroad, as well as by special air flights (Tengizchevroil LLP, 2019).

Kulsary at the same time is the nearest railway station connecting Tengiz field Industrial zone with other regions of Kazakhstan. The history of geological general development of whole Peri-Caspian region, and also investigated area in Pleistocene (Quarternary) Holocene period is identified by series of specific global phenomena directly affected the formation of geological environment of the region at stated geological time period (*Pillans* B. et al., 2012).

• First of all, this is the paleoclimatic conditions which demonstrate the continental glaciation within whole Northern hemisphere (4 glacial (drift) periods). The Glacial periods in Earth's history are connected with the Pleistocene – Holocene (Quarternary) periods of its development (Gibling Martin R., 2018).

• Structural and tectonical processes having caused the epeirogenic movement of earth crust resulted in four great transgressive and regressive cycles of the Caspian Sea.

The identifying feature of the Pleistocene and Holocene period marine sediments is their facies heterogeneity over time, and this is demonstrated by variety of lithological facies (random interstratification), and also by their random interchange in time according to the density of altering horizons (so called flushoid form peculiar to shallow sea basins). This phenomenon is well visible in CPT'u charts, especially in marker horizon strata.

Soils developed as a result of area natural and historical forming processes are divided by us into 3 unlithified sediments stratigraphic-and-genetic complexes, the description of which isgiven below (top to bottom).

The separate stratigraphic-genetic complex distinguishes a saline stratum (EGE-1a), which is uncovered in all tops of boreholes under wastewater (water depth is 0.20m-0.40m), formed as a result of the constant filling of saline groundwater (Heyuan W. et al., 2019). The saline stratum is white, dense; cannot bepenetrated manually (Figure1). The thickness of stratum is close to the shore 0.1-0.25 m, inthe middle of the sor site 0.3-0.7m.

Figure 1 - Saline stratum

First complex: Unlithified sediments of marine genesis Holocene (New Caspian) age: mQ_4nk. It is represented by loamy ooze (EGE-1) and uncovered by all drilled boreholes (*Zekkos* D. et al., 2008).

• Loamy ooze (EGE-1): gray, dark-gray, greenish-brown with sea weed residues, it has H_2S odor, with abundant solid and broken Cardium edule shells. The soil is very soft- soft, extremely saline, it contains carbonates and organic substances, moderately gypsumized. Under the influence of dynamic loads it is possible to have thixotropic properties developed. By physical and mechanical properties altogether it is related to slightly saturated clayey soils group. In the upper horizons of the soil, it was exposed to technogenic factors, as a result of which there was the decompaction process and associated changes in physical and mechanical properties.

Second complex: Unlithified sediments of marine genesis Upper Pleistocene (Khvalyn) age– mQ_3hv. They are distributed ubiquitously and occur under the first complex sediments. They arerepresented arenaceous sandy loam (EGE-2) and light silty clay (EGE-3).

• Arenaceous sandy loam (EGE-2) – brown, yellowish-brown, very soft-stiff, calcareous. The soil is extremely saline; it contains carbonates and organic substances, slightly gypsumized. It is a facies variety of sand enriched with clay particles.

• Light silty clay (EGE-3) is brown, buff-brown, stiff, and calcareous. The soil is extremely saline; it contains carbonates and organic substances, slightly gypsumized. It has weak swelling properties. It was uncovered by all drilled boreholes in the designed area.

Third complex. Unlithified sediments of marine genesis Middle Pleistocene (Hazar) age– mQ_2hz. They are distributed ubiquitously and uncovered under second complex sediments.

• Light arenaceous loam, excessively gypsumized (EGE-4), gray,

calcareous. It is a marker horizon that determines the position of sediments top of the third stratigraphic- and-genetic complex of sediments.

It consists of amorphous gypsum, mixed with sand and clay material. The gypsum content is up to 51.91%. By mechanical composition and degree of plasticity of terrigenous component, the soil is identified with light arenaceous loam. The soil was formed as a result of exposure, over a long geological time, of a complex of exogenous factors to the salt subjacent intrusives of salt-dome structures that reached the aeration zone. Under the influence of physical and chemical processes, salt subjacent intrusives exposed to the intensive leaching, withdrawal of freely and medium-soluble salts with their subsequent redeposition and crystallization, resulting in the formation of "dispersion areolas" of leached salts, while more rapidly crystallizing gypsum was accumulated in higher concentrations, forming a stratum of gypsum-bearing soil.

The soil is very stiff; it contains carbonates and insignificant amount of organic substances.

• Arenaceous sandy loam (EGE-5) is greenish-brown and brown, very stiff, calcareous, moderately gypsumized with separate horizons and thin lenses of calcareous-carbonate marl; it contains carbonates and insignificant amount of organic substances. The soil is excessively saline.

• Light arenaceous loam (EGE-6) is brown, very stiff, calcareous, slightly gypsumized, with thin sand lenses, the soil is extremely saline; it contains carbonates and insignificantamount of organic substances.

• Light arenaceous clay (EGE-7) is light brown and brown, very stiff, calcareous, and moderately gypsumized. The soil is extremely saline; it contains carbonates and insignificant amount of organic substances. It has weak swelling properties.

The above described unlithified sediments stratigraphic and genetic complexes and their constituent lithologic-and-facies soil groups (engineering geological elements – EGE) distribution is specified in the geotechnical cross-sections.

The names, geological age and thicknesses of EGE for individual boreholes are shown below inthe form of table 3.

Table 3 - Geological age and thicknesses of EGE for individual boreholes

No	Borehole No (BH)	Name, geological age and thickness of EGE								
		1a	1	2	3	4	5	6	7	
		Saline stratum	Loamy ooze	Arenaceous sandy loam	Light silty clay	Light loam, excessively gypsumized	Arenaceous sandy loam	Light arenaceous loam	Light silty clay	Total, m
			mQ_4nk	mQ_3hv		mQ_2hz				
1	B48-1-04	0.20	2.00	1.50	4.30	-	-	2.00	-	10.00
2	B48-1-07	0.50	8.00	0.50	-	6.20	1.30	-	3.50	20.00
3	B48-1-08	0.50	4.50	1.00	2.00	0.70	2.10	9.50	1.50	20.00
4	B48-1-11	0.50	3.50	0.50	4.00	-	1.00	7.90	2.60	20.00
5	B48-1-12	0.40	11.00	-	-	-	-	6.00	2.60	20.00
6	B48-1-15	0.70	2.80	0.75	4.25	1.50	-	7.40	2.60	20.00
Min. thickness, m		0.20	2.00	0.50	2.00	0.70	1.00	2.00	1.50	10.00
Max. thickness, m		0.70	11.00	1.50	4.30	6.20	2.10	9.50	3.50	20.00
mQ_4nk		Unlithified sediments of marine genesis Holocene (NewCaspian) age								
mQ_3hv		Unlithified sediments of marine genesis Upper Pleistocene (Khvalyn) age								
mQ_2hz		Unlithified sediments of marine genesis Middle Pleistocene (Hazar) age								

Discussion. Above described stratigraphic and genetic complex of sediments is broken down by us into 7 lithologic and facies groups of soils (engineering geological elements (EGE)) the physical- mechanical and chemical characteristics of which are given below. Soil groups due to mechanical and manual digging are given in accordance with the RoK SN 8.02-05-2002 requirements, collected volume 1. The content of sulfate anions in EGE soils represented on the 2-nd figure.

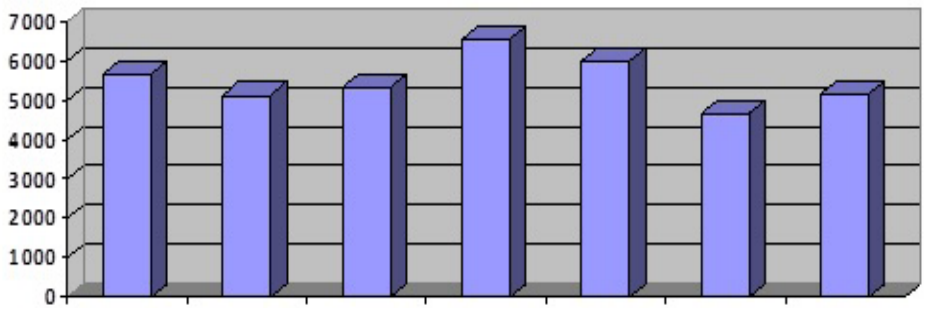

Figure 2 - The content of sulfate anions in EGE soils

As can be seen in Figure 2, the degree of aggressive effect of sulfates in soils on concrete grades of waterproofness shows that for all grades of cements, the content of sulfates varies from 4679 to 6562 mg/kg. The highest content is characteristic of EGE-4 (6562 mg/kg) light loam, excessively gypsumized, and the lowest indicators are characteristic of EGE-6 (4679 mg/kg), which refers to light arenaceous loam (Yessenamanova, M.S. et. Al., 2020). The average indicators are noted for EGE-2,3 and 7 (approximately 5 thousand mg/kg). It is an arenaceous sandy loam and light silty clay.

Table 4 shows the degree of aggressive action of sulphates in soils on concrete of water resistance gradesW4-W20.

Table 4- Degree of aggressive action of sulphates in soils on concrete of water resistance gradesW4-W20, mg/kg

		EGE-1	EGE-2	EGE-3	EGE-4	EGE-5	EGE-6	EGE-7	
Portland cement as per GOST 10178	W4	5 692	5 141	5 334	6 562	6 024	4 679	5 174	highly aggressive
	W6	5 692	5 141	5 334	6 562	6 024	4 679	5 174	highly aggressive
	W8	5 692	5 141	5 334	6 562	6 024	4 679	5 174	highly aggressive
	W 1 0 - W14	5 692	5 141	5 334	6 562	6 024	4 679	5 174	highly aggressive
	W 1 6 - W20	5 692	5 141	5 334	6 562	6 024	4 679	5 174	highly aggressive
Portland cement as per GOST 10178 with percentage of C_3S not more than 65%, C_3A not more than 7 %, C_3A + C_4AF not more than 22 % and blast-furnace cement	W4	5 692	5 141	5 334	6 562	6 024	4 679	5 174	highly aggressive
	W6	5 692	5 141	5 334	6 562	6 024	4 679	5 174	moderately aggressive
	W8	5 692	5 141	5 334	6 562	6 024	4 679	5 174	slightly aggressive
	W 1 0 - W14	5 692	5 141	5 334	6 562	6 024	4 679	5 174	non-aggressive
	W 1 6 - W20	5 692	5 141	5 334	6 562	6 024	4 679	5 174	non-aggressive
Sulfate resistant cement as per GOST22266	W4	5 692	5 141	5 334	6 562	6 024	4 679	5 174	non-aggressive
	W6	5 692	5 141	5 334	6 562	6 024	4 679	5 174	non-aggressive
	W8	5 692	5 141	5 334	6 562	6 024	4 679	5 174	non-aggressive
	W 1 0 - W14	5 692	5 141	5 334	6 562	6 024	4 679	5 174	non-aggressive
	W16-W20	5 692	5 141	5 334	6 562	6 024	4 679	5 174	non-aggressive

In Table 2, we can see that highly aggressive to sulfates are Portland cement asper GOST 10178 grades W6, W8, W10-W14, W16-W20, W4; moderately and slightly aggressive Portland cement as per GOST 10178 with percentage of C_3S not more than 65%, C_3A not more than 7%, $C_3A + C_4AF$ not more than 22 % and blast-furnace cement's grade of W6 and W8. Other grades of Portland cement as per GOST 10178 and Sulfate resistant cement as per GOST22266 are non-aggressive.

The content of sulfate anions in EGE soils represented on the 3-rd figure.

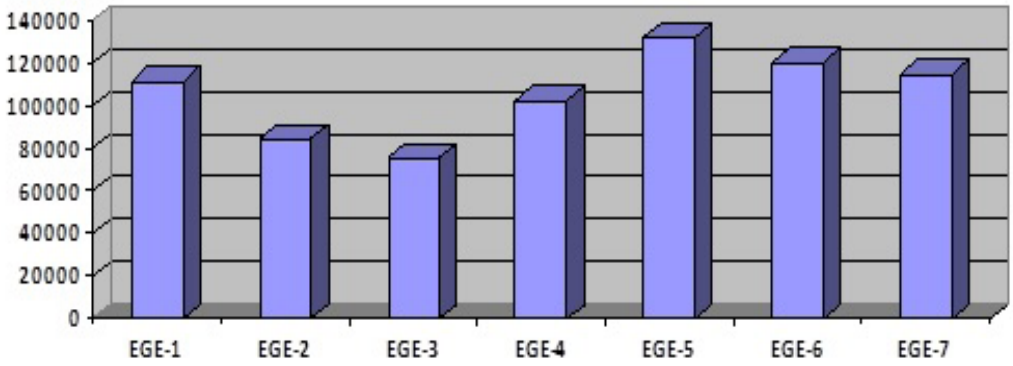

Figure 3 - The content of chloride anions in EGE soils

As can be seen in Figure 3, the degree of aggressive action of chlorides in soils on concrete grades of waterproofness shows that for all grades of cements, the chloride content varies from 75410 to 132250 mg/kg. The highest content is characteristic of EGE-5 (132250 mg/kg) of light loam, excessively plastered, and the lowest indicators are characteristic of EGE-3 (75410 mg/kg), which refers to light sandy loam. Average indicators are noted for EGE-1, 4 and 7 (approximately one hundred and thousand) (Yessenamanova M.S. et al., 2021).

Table 5 shows the degree of aggressive action of chlorides in soils on concrete of water resistance gradesW4-W20.

Table 5- Degree of aggressive action of chlorides in soils on concrete of water resistance gradesW4-W20, mg/kg

		EGE-1	EGE-2	EGE-3	EGE-4	EGE-5	EGE-6	EGE-7	
Portland cement, blast-furnace cementas per 10178 and sulfate-resistant cement as per GOST 22266	W4-W6	111 635	84 750	75 410	102 980	132 250	120 725	115 143	highly aggressive
	W8	111 635	84 750	75 410	102 980	132 250	120 725	115 143	highly aggressive
	W10-W14	111 635	84 750	75 410	102 980	132 250	120 725	115 143	highly aggressive

In Table 3, we can see that the highly aggressive to chlorides are all of grades of Portland cement, blast-furnace cement as per 10178 and sulfate-resistant cement as per GOST 22266.

According to the content of sulfates according to Table 1 (GOST 31384-2008), we see that for the dry zones characterized by the studied region of the Tengizchevroil deposit, all soils are highly aggressive with respect to Portland cement, since the content of sulfates in soils exceeds 1500 mg/kg. For Portland cement with a C_4S content of no more than 65%. CaA no more than 7%, CA + C4AF hc more than 22% and slag-Portland cement, this soil belongs to the medium aggressive, since their content is in the repartitions from 4000 to 5000 mg/ kg, except for EGE-4 and EGE-5, where the content of sulfates exceeds 6000 mg/kg. For sulfate-resistant cements, all groups of soils belong to mildly aggressive types.

For all types of cement, taking into account chlorides in terms of concretes on Portland cement, slag-Portland cement and sulfate-resistant cements, the chloride content above 7500 mg/kg (GOST 31384-2008) is considered highly aggressive. Accordingly, the chloride content from 75410 to 132250 mg/kg higher than 10-17 times indicates a very high aggressiveness of soils to all types of cements.

Conclusion. The investigated area is a part of Zhylyoi region of Atyrau oblast of Republic of Kazakhstan and located within the western part of Tengiz field Industrial Zone. "Tengizchevroil" Company is the owner of the area within Tengiz field. The investigated territory, sor site is located in the west areas of Tengiz field near 3GI plant under construction. The movement along the investigated territory is possible only by means ofoff-road transport and crawler vehicle.

All lithologic-and-facies groups of soils building up the geotechnical cross-section downto a depth up to 20.0m are extremely salinized at chloride nature of salinity. All lithologic-and-facies groups of soils also contain the carbonates, gypsum and insignificant amount of organic substances.

The conducted research revealed 7 engineering-geological elements (EGE), which are characterized by various types of soils from sandy loam to loam to clay. According to the content of sulfates for the majority of the EGE, Portland cements range from non-aggressive to highly aggressive, whereas for chlorides, all types of Portland cements are highly aggressive.

As a result, 2 types of water were established: sewage and groundwater. By chemical composition, wastewater belongs to the brine group, a subgroup of strong brines. The groundwater within the investigated area has been uncovered by all the engineering and geological workings (drilling wells). By chemical composition, groundwater also belongs to the brine group, a subgroup of strong brines. Despite the difference in the types of wastewater and groundwater, their chemical composition is almost identical. According to the content of sulfates,

wastewater and groundwater are highly aggressive in relation to Portland cements and only in relation to sulfate-resistant cements are mildly aggressive. At the same time, in terms of chloride content, all types of waters are very highly aggressive in relation to all types of cements, and since the studied area may be subjected to artificial flooding, as a result of a powerful man-made impact on the geological environment associated with engineering and economic activities for the industrial development of the region, this can lead to deterioration of the physical and mechanical properties of soils. First of all, it is worth paying attention to the salinity of soils and high levels of chlorides in the soil, therefore it is recommended to provide measures that reduce the possibility of water getting under the foundations of buildings and structures, or their rapid removal in emergency situations. In the process of industrial and economic development of the territory, its flooding is inevitable, as a result of a seasonal rise in the level (close lying), excavation work, unregulated discharge of household effluents, etc. As a result, it is possible to form a "high-water mark" and an unpredictable rise of the UGV, which, in turn, can lead to a deterioration of the geological environment.

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ISSN 2224-5278 (Print)

Директор отдела издания научных журналов НАН РК *А. Ботанқызы*
Заместитель директор отдела издания научных журналов НАН РК *Р. Жәлиқызы*
Редакторы: *М.С. Ахметова, Д.С. Аленов*
Верстка на компьютере *Г.Д.Жадыранова*

Подписано в печать 14.10.2022.
Формат 70x90$^{1}/_{16}$. Бумага офсетная. Печать – ризограф.
20,0 п.л. Тираж 300. Заказ 5.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-19