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ENGINEERING AND GEOLOGICAL STUDIES OF THE TENGIZ DEPOSIT

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In this article, a study of geological and ecological loads on the geological environment at the Tengizfield, located in the Zhyloy district of Atyrau region of the Republic of Kazakhtan, is carried out. Soil tests by dynamic sounding (STDS) were performed on all drilling wells for sandy soils. In the process of performing engineering and geological exploration, static sounding of soils was performed at the projected sites of GDP-1 (gas distribution plant) and Torch, with the measurement of hydrostatic pore pressure. Physical and mechanical properties of soils, chemical properties of soils and chemical properties of groundwater were determined during laboratory studies. In the studied territory, the soils composing the engineering-geological section to a depth of up to 25 m are saline with an average degree of salinity. All lithological-facies groups of soils also contain a significant amount of carbonates and gypsum in their composition. For loamy silt (IGE-1b), according to the combination of physico-chemical and mechanical characteristics (fluid consistency, high degree of salinity, high degree of compressibility and low strength, the possibility of manifestation of thixotropic properties under dynamic influences), this soil belongs to the category of weak water-saturated clay soils. Weak soil (IGE-1b) is observed at a shallow depth in some areas. The available geotechnical data is not enough to accommodate areas of weak soils. At the same time, heavy sandy loam (IGE1a) and light sandy clay (IGE-8) have swelling properties of a weak degree. Chemical analysis of groundwater samples taken within the studied territories showed a high degree of mineralization, groundwater belongs to the brackish group, a subgroup of strongly brackish waters. Dangerous geological processes that could negatively affect the construction conditions are characterized by the processes of secondary salinization of soils.

KEY WORDS: *Tengizchevroil field, Soil tests by dynamic sounding, Physical and mechanical properties of soils, heavy sandy loam, light sandy clay.*

ТЕҢІЗ КЕН ОРНЫН ИНЖЕНЕРЛІК-ГЕОЛОГИЯЛЫҚ ЗЕРТТЕУ

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Ш. ЕСЕНОВ АТЫНДАҒЫ КАСПИЙ ТЕХНОЛОГИЯЛАР
ЖӘНЕ ИНЖИНИРИНГ УНИВЕРСИТЕТІ» КЕАҚ
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Бұл мақалада Қазақстан Республикасы Атырау облысының Жылой ауданында орналасқан Теңізшевройл кен орнындағы геологиялық ортаға түсетін геологиялық-экологиялық жүктемелерге зерттеу жүргізілді. Динамикалық зондтау (SPT) әдісімен топырақты сынау құмды топырақтарға арналған барлық бұрғылау ұңғымаларында орындалды. Инженерлік-геологиялық барлауды орындау барысында ГРУ-1 (газ тарату қондырғысы) мен Алаудың жобаланған алаңдарында гидростатикалық кеуек қысымын өлшей отырып, топырақты статикалық зондтау жүргізілді. Зертханалық зерттеулер кезінде топырақтың физика-механикалық қасиеттері; топырақтың химиялық қасиеттері және жер асты суларының химиялық қасиеттері анықталды. Зерттелген аумақта 25 м тереңдікке инженерлік-геологиялық кесінді құрайтын топырақтар орташа тұздану дәрежесіне жатады. Топырақтың барлық литологиялық-фациальды топтарында карбонаттар мен гипстердің едәуір мөлшері бар. Саздақ тұнбалары үшін (ИГЭ-1б), физикалық-химиялық және механикалық сипаттамалардың жиынтығы бойынша (сұйық консистенциясы, жоғары тұздану

дәрежесі, жоғары сығылу дәрежесі және төмен беріктігі, динамикалық әсер ету кезінде тиксотропты қасиеттерді көрсету мүмкіндігі), бұл топырақ әлсіз су қаныққан сазды топырақтар санатына жатады. Әлсіз топырақ (ИГЭ-1б) кейбір аудандарда таяз тереңдікте байқалады. Қолда бар геотехникалық деректер әлсіз топырақ телімдерін орналастыру үшін жеткіліксіз. Сонымен қатар, ауыр құмды саздақ (ИГЭ-1а) және жеңіл құмды саздақ (ИГЭ-8) әлсіз дәрежедегі ісіну қасиеттеріне ие. Зерттелген аумақтар шегінде алынған жер асты суларының сынамаларын химиялық талдау минералданудың жоғары дәрежесін көрсетті, жер асты сулары тұзды су тобына, қатты тұзды сулардың кіші тобына жатады. Құрылыс жағдайларына теріс әсер етуі мүмкін қауіпті геологиялық үдерістер топырақтың қайталама тұздану үдерістерімен сипатталады.

ТҮЙІН СӨЗДЕР: *Теңіз кен орны, динамикалық зондтау әдісімен топырақты сынау, топырақтардың физикалық-механикалық қасиеттері, ауыр құмдақ, жеңіл құмдақ саз.*

ИНЖЕНЕРНО-ГЕОЛОГИЧЕСКИЕ ИЗЫСКАНИЯ ТЕНГИЗСКОГО МЕСТОРОЖДЕНИЯ

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НАО «КАСПИЙСКИЙ УНИВЕРСИТЕТ ТЕХНОЛОГИИ И ИНЖИНИРИНГА ИМ. Ш. ЕСЕНОВА»
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Проведено исследование геолого-экологических нагрузок на геологическую среду на месторождении Тенгизшевройл, расположенной в Жылойском районе Атырауской области Республики Казахтан. Испытания грунта методом динамического зондирования (SPT) выполнены по всем буровым скважинам для песчаных грунтов. В процессе выполнения инженерно-геологической разведки, на проектируемых площадках ГРУ-1 (газораспредилительной установки) и Факела, было произведено статическое зондирование грунтов, с измерением гидростатического порового давления. При лабораторных исследованиях определены физико-механические свойства грунтов; химические свойства грунтов и химические свойства грунтовых вод. На исследованной территории грунты, слагающие инженерно-геологический разрез на глубину до 25м относятся к засоленным при средней степени засоления. Все литолого-фациальные группы грунтов также содержат в своем составе значительное количество карбонатов и гипсов. Для ила суглинистого (ИГЭ-1б), по совокупности физико-химических и механических характеристик (текучая консистенция, высокая степень засоления, высокая степень сжимаемости и низкая прочность, возможность проявления тиксотропных свойств под динамическими воздействиями) данный грунт относится к категории слабых водонасыщенных глинистых грунтов. Слабый грунт (ИГЭ-1б) наблюдается на небольшой глубине в некоторых районах. Имеющихся геотехнических данных недостаточно для размещения участков слабых грунтов. В то же время суглинок тяжелый песчанистый (ИГЭ-1а) и глина легкая песчанистая (ИГЭ-8) обладают набухающими свойствами слабой степени. Химический анализ проб грунтовых вод, отобранных в пределах исследованных территорий показал высокую степень минерализации, грунтовые воды относятся к группе солоноватых, подгруппе сильносолоноватых вод. Опасные геологические процессы, которые отрицательно могли бы повлиять на условия строительства, характеризуются процессами вторичного засоления грунтов.

КЛЮЧЕВЫЕ СЛОВА: *месторождение Тенгиз, испытания грунтов методом динамического зондирования, физико-механические свойства грунтов, тяжелая супесь, легкая супесчаная глина.*

Introduction. Kazakhstan holds a leading position in the world in oil and gas production. Oil production in Kazakhstan is carried out in the western regions of the country [1]. The project area where the geotechnical investigations have been provided is located in Zhylyoi district of Atyrau region.Tengiz is an oil and gas field in the Atyrau region of Kazakhstan, 350 km southeast of Atyrau. It belongs to the Caspian oil and gas province [2].

The investigated area is a part of Zhylyoi region of Atyrau oblast of Republic of Kazakhstan andlocated within the western part of Tengiz field Industrial Zone. "Tengizchevroil" Company is theowner of the area within Tengiz field. The district center, the town of Kulsary is located at the distance equal to 110km (*Figure 1*); it is reached by asphalt motor road and railroad connecting Kulsary and Tengiz field [3].

Kulsary at the same time is the nearest railway station connecting Tengiz field Industrial zonewithother regions of Kazakhstan.

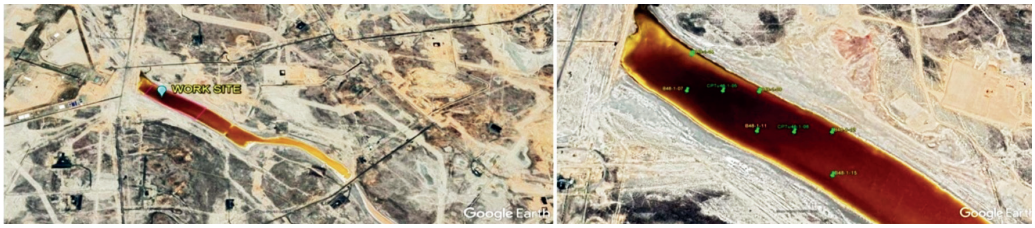

Figure1 – **Location of investigated area. Picture from application "Googlemap"**

Ingeneral, the soil drilling and sampling consisted of the following stages of work:

- Horizontal and vertical positioning of geotechnical boreholes;
- Delivery and preparation of the tools and equipment for drilling of geotechnical boreholes;
- Installation of drilling equipment at the borehole location;
- Drilling of the boreholes;
- Collection of undisturbed soil samples by tube samplers;
- Standard penetration test (SPT) and disturbed soil sampling;
- Inspection of all sampling tools/tubes prior to sampling and replacement if any damage is observed;
- Collection of groundwater sample;
- Measurement of the GWT in the borehole;
- Removal of all drilling augers and casings from the borehole;
- Tear down and storage of all drilling and boring tools;
- Restoring the drill location one aritsinitial condition and return the top soil to its origina lposition;
- Moving of drilling rig and equipment to the next drilling location;
- Delivery of all soil samples to the geotechnical laboratory fo rlaboratory testing.

Based on the results of dynamic soil sounding (SPT) at the investigated site, it was possible to solve the following tasks:

- calculate the conditional dynamic resistance of the soil, Pd.
- determine the density of the addition of the above ground differences.

• determine the average values of deformation modules for sands.

• determine the average values of the internal friction angles for these types of soils.

• calculate the compaction coefficient for the same soils.

The main tasks set during CPT testing were the following:

• Setting exact limits between sediment genetic stratigraphic complexes and soil lithologic-and-faciesgroups buildingthem (EngineeringGeological Elements- EGE);

• Clarifying the description of found out soil lithologic-and-facies groups (EGE);

• Clarifying the space and time limit so marker horizons;

• Identifying the degree of heterogeneity over space and time according to the lithological parameters, as well as according to the consistency (density) for marker horizons with relation to their random (irregular) changes within the element, or such is the regularity observed, so it can be neglected, and this allows to identify the lithological and faciesgroups of soils (engineering geological elements), without splitting them into two or several separate small layers;

• Clarifying the physical parameters of sandy and clayey soils within established lithogical-and-facies groups in the most objective version;

• Determining or clarifying the standard values of the undisturbed (naturally moisturized) soils mechanical properties;

• All above mentioned tasks were successfully performed, but only with in the limits of cone penetrated depths;

• The construction of charts and interpretation of results obtained by software have beenperformedusing “GEOEXPLORER”program.

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 characteristics of which are given below (from top to bottom).

The first complex. Unlicensed deposits of Holocene (New Caspian) age of marine genesis-mQ4nk.

• Heavy sandy loam (IGE-1a) of brownish-brown, greenish-brown and brown color, solid consistency, calcareous, with the inclusion of gypsum, with interlayers and low-power lenses of sand. The soil has an average degree of salinity, contains an insignificant amount of organic substances, has weakly wrinkled, swelling and subsidence properties of a weak degree. The type of drawdown is the first.

• Loamy silt (IGE-1b) from dark gray to black, fluid consistency, calcareous, with an abundance of whole and broken shells of Cardiumedule, with rotted remnants of seaweed, with the smell of hydrogen sulfide, with layers and low-power lenses of sand. The soil is of medium salinity, contains a small amount of organic substances. Under the influence of dynamic loads, the manifestation of thixotropic properties is possible. According to the totality of physical and mechanical characteristics, it belongs to the group of weak water-saturated clay soils [1-2].

The second complex. Unlicensed sediments of the Upper Pleistocene (Khvalynsky) age of marine genesis - mQ3hv. They are widespread everywhere and lie under the sediments of the first complex. They are represented by mixed-grained sand (IGE-2), light sandy loam (IGE-3) and light powdery clay (IGE-4).

• The thickness of the sand is characterized by facies heterogeneity: the unsystematic layering of facies varieties from dusty differences to medium-sized sands is characteristic.

Based on the provisions of GOST 20522-2012, section 4, the sand thickness is characterized by us, according to the set of classification characteristics, as fine sand (IGE-2), which is part of the engineering-geological model of the object.

The soil is above the UGV of loose addition, below the UGV of medium-dense addition; above the UGV - low-moisture, below the UGV – from moist to water-saturated. The soil is of medium salinity, calcareous, from medium density to dense addition, with the inclusion ofgypsum.They are distributed everywhere and are opened by all drilled wells located on all sites and linear structures [4].

According to the results of dynamic sounding (SPT), the sand thickness is divided into 2 zones:

- Zone 1. The sand is fine, loose-built, low-moisture (IGE-2a) - developed in the roof of the thickness. The lower limit of the distribution of loose sand is determined by the depth of the groundwater level.

- Zone 2. Fine sand, medium-density composition, from moist to water-saturated (IGE-2b) - the upper limit of the distribution of medium-density sand is determined by the depth of the groundwater level.

• Light sandy loam (IGE-3), brown, brownish-brown, semi-solid, calcareous, with the inclusion of gypsum. Soil of medium degree of salinity.

• Light powdery clay (IGE-4) of greenish-brown, dark brown and brown color, hard, calcareous, with the inclusion of gypsum. Soil of medium degree of salinity.

The third complex. Unlicensed sediments of the Middle Pleistocene (Khazar) age of marine genesis – mQ2hz. They are widespread everywhere and are exposed under the deposits of the second complex.

• Excessively plastered soil (IGE-5) of gray color, calcareous. It is a marking horizon that determines the position of the roof of sediments of the third stratigraphic-genetic complex of sediments. It consists of amorphous gypsum mixed with sandy–clay material. The gypsum content ranges from 15% to 80.1% (standard – 37.17 %). According to the mechanical composition and the degree of plasticity of the terrigenous component, the soil is identified with a light sandy loam. The soil was formed as a result of the impact, over a long geological time, of a complex of exogenous factors on the salt rods of salt dome structures that reached the aeration zone. The soil is of a solid consistency, medium saline.

• Sandy sandy loam (IGE-6) of brownish-gray, gray to dark gray color, solid consistency, calcareous, slightly gypsum, with separate horizons and low-power lenses of calcareous-carbonate marl, medium saline.

• Light sandy loam (IGE-7), greenish-gray, gray in color, solid consistency, calcareous, medium-gypsum, with low-power lenses of sand, medium degree of salinity.

• Light sandy clay (IGE-8), brown color, solid consistency, calcareous, slightly gypsum, medium degree of salinity. It has swelling properties of a weak degree.

• Sandy sandy loam (IGE-9), greenish-brown color, solid consistency, slightly gypsum. It was opened in engineering-geological wells with a depth of up to 25.0 m, under the deposits of IGE-8, in the Flare site[5].

Material and methods. The main type of field investigations is geotechnical survey consisting of the following type of works:

• Drilling of geotechnical bore holes and soil sampling with concurrent execution of SPT testing for sands, ground water sampling;

• Cone Penetration Test (CPTu);

The following is a list of the activities that have been completed prior to starting the work:

• Familiarization with all site specific regulations, procedures, underground services, workhours, and any other logistics related to site access and start of the work;

• Obtaining the appropriate work permits before entering and start of the work at any sites.

The boreholes have been drilled at the sor site MMWP 48-1 by means of all terrain drilling rig “ARDKO” (Country of manufacture-USA). Bore hole drillings are supported with casings. Drilling diameter is up to 108mm.

The undisturbed soil samples have been taken by means of driving tube sampler GK-123 designed by “Hydroproject” JSC while drilling the geotechnical bore holes. All selected undisturbed soil samples (monoliths) have been packed and documented in compliance with the requirements of GOST 12071-2000 “Soils. Sampling packing, transportation and storage ofsamples”. The samples were protected against extreme temperatures, direct sunlight, humidity and frost [6].

The Standard Penetration testing (SPT) has been carried out for sandy soils by means ofstandard penetration sampler (Automatic drop hammer SPT) and disturbed soil samples have been collected to determine the indexes of soil physical and chemical properties.

The numbers and coordinates ofcollected disturbed and undisturbed soil samples, as well as groundwater sample are givenbelowin the form of *table 1* [7].

Table 1 - **The numbers and coordinates ofcollected disturbed and undisturbed soil samples, as well as groundwater sample**

ItemNo.	BoreholeNo.	Boreholecoordinates								
		E	N							
1	BH-1/21	688731.996	5115685.564	-24.96	5		3	3		torch
2	BH-2/21	688720.525	5115471.24	-24.566	25	8	10	18	1	torch
3	BH-3/21	688716.229	5115398.645	-24.612	25	9	8	17		torch
4	BH-4/21	688699.832	5115212.744	-24.537	5		3			torch
5	BH-5/21	688519.476	5115482.562	-24.454	25	8	10	18		torch
6	BH-6/21	688515.083	5115410.158	-24.476	25	9	9	18	1	torch
7	BH-7/21	688411.588	5115704.561	-24.579	5		3	3		torch
8	BH-8/21	688363.831	5115232.068	-24.834	5		3	3		torch
9	BH-9/21	688281.107	5115465.49	-24.533	5		3	3		gas distribution system
10	BH-10/21	688207.755	5115597.806	-24.487	5					gas distribution system
11	BH-11/21	688111.447	5115581.257	-24.542	20	4	10	14	1	gas distribution system
12	BH-12/21	688106.636	5115497.256	-24.474	20	7	8	15	1	gas distribution system
13	BH-13/21	688092.925	5115297.679	-24.911	20	4	10	14	1	gas distribution system
14	BH-14/21	688018.313	5115586.144	-24.779	20	6	8	14		gas distribution system
15	BH-15/21	688008.959	5115426.326	-24.896	20	9	6	15	1	gas distribution system
16	BH-16/21	687997.958	5115261.231	-25.226	20	2	12	14	1	gas distribution system

Table 1 - **The numbers and coordinates ofcollected disturbed and undisturbed soil samples, as well as groundwater sample**

17	BH-17/21	687918.532	5115592.895	-24.842	20	4	10	14	1	gas distribution system
18	BH-18/21	687909.661	5115507.716	-24.904	20	8	7	15		gas distribution system
19	BH-19/21	687903.189	5115339.912	-24.912	20	7	7	14		gas distribution system
20	BH-20/21	687898.242	5115268.043	-25.078	20	1	13	14	1	gas distribution system
21	BH-21/21	687818.764	5115599.828	-24.513	20	5	9	14		gas distribution system
22	BH-22/21	687809.109	5115434.292	-24.886	20	3	11	14	1	gas distribution system
23	BH-23/21	687798.525	5115274.966	-24.815	20	7	7	14	1	gas distribution system

Standard penetration test (SPT) has been done at all geotechnical boreholes for sandy soils bymeans of attachable equipment Died rich automatic SPT hammer designed and manufactured inUSA.

In-house processing of the obtained results was performed in accordance with the requirements of GOST 19912-2012; SP RK 1.02.-102-2014. In accordance with the requirements of the above-mentioned State and Interstate standards and Building codes, calculations based on the results of dynamic sounding (SPT) apply to all types of sands and other categories of soils equated to them.

When performing geotechnical surveying the Cone Penetration Tests with measurements of pore water pressure have been provided within surveyedarea prior to commencement of boreholes drilling. The cone penetration testing has been provided with electric CPT probed signed by “GeoMil” (Netherlands), by means of self-propelled caterpillar mounting MTLB. The full weight of the unit is 10.0 tonnes. The USZG unit allows providing soil testing by CPTu (in compliance with the international classification). The following soil parameters have been obtained byCPTu: cone resistance (qc), sleeve friction (fs) and pore pressure (u) [8].

The quantity, coordinates, elevations and depths of CPTu points are given below in the form of *table 2*.

Table 2 - **The quantity, coordinates, elevations and depths of CPTu points**

ItemNo	CPTuNo	CPTuCoordinates		CPTu elevations,m	CPTu depth,m
		E	N		
1	CPTu-2	688702,522	5115473,314	-24,321	11.35
2	CPTu-3	688698,032	5115400,940	-24,556	10.90
3	CPTu-5	688496,407	5115481,235	-24,628	11.65
4	CPTu-6	688492,357	5115407,816	-24,163	11.79
5	CPTu-11	688099,799	5115397,455	-24,697	11.09
6	CPTu-14	688163,108	5115256,650	-24,989	9.56
7	CPTu-16	688016,030	5115492,309	-24,657	10.46
8	CPTu-18	688006,282	5115317,961	-24,861	10.51
9	CPTu-19	687901,605	5115416,867	-24,963	9.16
10	CPTu-20	687814,986	5115506,764	-24,852	9.69
11	CPTu-21	687805,002	5115336,712	-24,983	9.76
TOTAL	11 CPT				115.92

The required soil and ground water samples complex laboratory investigations have been provided by the SRDI Caspiymunaygas JSC Geotechnical Laboratory, under the guidance of N.U.Yesembekova, Laboratory Manager. The SRDI Caspiymunaygas JSC Geotechnical Laboratory has been entered the Republic of Kazakhstan accreditation system; Accreditation CertificateNoKZ.И.06.1397, issued by "National Center for Accreditation"LLP, Astanacity.

All types of tests have been provided in compliance with State and Interstate regulatory documents and standards (MNTKS and RoK). The tests have been provided using the modern equipment and apparatus,both native and foreign manufacturer which have undergone certification and annual inspection at "NCEC" (National Center for Expertise and Certification) OJSC metrological center. The tests have been performed by highly skilled specialists having higher professional education[9].

The main soil properties determined during laboratory investigations:

- Soil physical and mechanical properties;
- Soil chemical properties;
- Ground water chemical properties.
- Waste water chemical properties.

The scope of provided laboratory works is given below in the form of *table 3*.

Table 3 - **The scope of providedl aboratory works**

Soilproperties	ItemNo	Types of tests and relevant GOSTs (Statestandards)	Unit	Testsdone
Physical	1	Grain-sizeanalysis,%,GOST12536-79	1analysis	25
	2	Soil Particles density ρsig/cm3; RoKST1290-2004	1analysis	27
	3	Soil Density p,g/cm3Ro KST1290-2004	1analysis	9
	4	Dry Soil densityρd,g/cm3 RoKST1290-2004	1analysis	9
	5	Soil moisture content by way of drying up to constant massW, f.u.RoKST1290-2004	1analysis	30
	6	Porosityn,%GOST25100-2011	1analysis	9
	7	Voidratio,GOST25100-2011	1analysis	9
	8	Liquid limit using so called Balance Cone method(fall-cone method),f.u.RoKST1290-2004	1analysis	17
	9	Plastic limit by pressing method,f.u.RoKST1290-2004	1analysis	17
	10	Plasticity index Ip, f.u. RoK ST 1290-2004,GOST25100-2011	1analysis	17
	11	Liquidity IndexIL;GOST 25100-2011	1analysis	17
Mechanical	12	Shear Strengthtest (single-plane) GOST12248-2010	1test	37
	13	Oedometer Compression test; GOST 12248-2010	1test	45
	14	Swelling RoKST1550-2006,f.u.	1test	25
	15	Subsidence (collapsible) GOST23161-2012	1test	7
	16	Water extract dissolved solids, % GOST26423-85	1analysis	88
	17	Gypsum percentage CaSO4*2H2O, %E.V.Arinushina	1analysis	88

Table 3 - **The scope of providedl aboratory works**

Chemical	18	Carbonate percentage, $CaCO_3$;E.V.Arinushina	1analysis	85
	19	Organic substances %,GOST23740-79	1analysis	67
	20	Water extract GOST26423-26428-85	1analysis	83
	21	Groundwater chemical analysis, GOST26449.1-85	1analysis	5
	22	Wastewaterchemicalanalysis,GOST 26449.1-85	1analysis	3

All various and multiple raw data was systemized and statistically processed during office works:

a) field works including geotechnical exploration (boreholes), SPTand CPT utesting;

b) Soil and ground water laboratory test results;

The statistical processing of obtained and collected information is, first of all, based on the Interstate standard "GOST20522-2012. Soils. Test results statistical processing methods "requirements, and also other fundamental State and Interstate regulations and legislative instruments.

As a result of which an information concerning are a 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 ground water 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 faciesgroups of soils, i.e. marker horizons, both by the lithology and by the degree of density. This allowed distinguishing EGE-2 asasing lemarker horizon, without differentiating the mintoseparate thin lithological varietie saccording to the requirements of GOST20522-2012.

Complex of distinguished lithological-and-facies groups (engineering geological elements-EGE)r e-create the geotechnical model of the facility.

Results and discussion. During the production of engineering and geological exploration within the studied area, all the engineering and geological workings (drilling wells) have opened the horizon of highly mineralized non-pressurized groundwater.

The natural sources of the aquifer's nutrition are atmospheric precipitation and regional inflow from the north and northeast.

In recent decades, due to the intensive industrial and economic development of the Caspian region, artificial flooding of the territory associated with the leakage of large volumes of water from faulty engineering networks and other water-using structures within large industrial zones, oilfield zones, household facilities, unregulated wastewater discharge has become an increasingly important source of supply for the aquifer. watering of green spaces, etc. This phenomenon is associated with a significant increase in hydrocarbons, a decrease in its mineralization, deterioration of the geological and environmental conditions.

The rapid increase of hydrocarbons and the formation of "upper water" can be facilitated by the occurrence, at an insignificant depth, of a water-resistant layer in the form of clay soils.

The seasonal fluctuation of hydrocarbons will be 0.50 m-0.70 m.

The main values of the hypsometric position of hydrocarbons (in absolute marks), in combination with the absolute marks of the mouths of drilling wells drilled at the projected sites and linear structures, as well as the results of chemical analysis of groundwater samples and the degree of their aggressiveness are given below.

The main values of the hypsometric position of hydrocarbons (in absolute marks), combined with the absolute marks of the mouths of drilling wells drilled at the projected sites, as of April 2022, are presented in *Table 4* [10].

Table 4 - **The main values of the hypsometric position of hydrocarbons (in absolute marks), combined with the absolute marks of the mouths of drilling wells drilled at the projected sites, as of April 2022**

Groundwaterlevel					Estimatedgroundwaterlevel, m
N	Well number	Wellhead marks, m	Depth of groundwater (hydrocarbons), m	Hydrocarbon mark, m	
1	BH-1/21	-24,960	1,30	-26,26	0,76
2	BH-2/21	-24,566	1,90	-26,47	1,18
3	BH-3/21	-24,612	1,80	-26,41	1,16
4	BH-4/21	-24,537	1,75	-26,29	1,10
5	BH-5/21	-24,454	1,90	-26,35	1,18
6	BH-6/21	-24,476	2,15	-26,63	1,37
7	BH-7/21	-24,579	1,70	-26,28	1,06
8	BH-8/21	-24,834	1,70	-26,53	1,06
9	BH-9/21	-24,533	1,60	-26,13	0,97
10	BH-10/21	-24,487	1,80	-26,29	0,90
11	BH-11/21	-24,542	2,20	-26,74	1,51
12	BH-12/21	-24,474	2,30	-26,77	1,46
13	BH-13/21	-24,911	1,60	-26,51	0,97
14	BH-14/21	-24,779	1,70	-26,48	1,06
15	BH-15/21	-24,896	2,20	-27,10	1,51
16	BH-16/21	-25,226	1,80	-27,03	1,16
17	BH-17/21	-24,842	1,80	-26,64	1,16
18	BH-18/21	-24,904	1,80	-26,70	1,16
19	BH-19/21	-24,912	1,60	-26,51	0,96
20	BH-20/21	-25,078	1,60	-26,68	0,96
21	BH-21/21	-24,513	1,60	-26,11	0,96
22	BH-22/21	-24,886	1,80	-26,69	1,16
23	BH-23/21	-24,815	1,90	-26,72	1,18

Chemical analysis of groundwater samples taken within the investigated site showed a high degree of mineralization. The main values of the dry (dense) residue range from 10700 mg/liter to 21700.0 mg/liter, the standard value is 16769.0 mg/liter, which corresponds to a group of brackish, a subgroup of strongly brackish waters[11-12].

The results of chemical analysis of groundwater samples and the degree of their aggressiveness are presented below, in the form of *tables 5-9*.

Table 5 - **The results of chemical analysis of groundwater samples**

Indicator	Index	Unit. ed.	Values		
			Xmin	Xmax	Xn
Anions					
Bicarbonateion	HCO_3^{--}	mg/dm³	366,00	1 024,80	486,12
		meq	6,00	16,80	7,97
		%			0,3
Chlorineion	Cl^-	mg/dm³	3 850,00	12 250,00	8 332,69
		meq	1 100,00	3 500,00	2 380,77
		%			98,7
Sulfateion	SO_4^{--}	mg/dm³	309,40	2 146,40	1 154,60
		meq	6,45	44,71	24,05
		%			1,0
Cations					
Calciumion	Ca^{++}	mg/dm³	1 000,00	4 000,00	2 076,92
		meq	49,90	199,60	103,64
		%			4,30
Magnesiumion	Mg^{++}	mg/dm³	3 600,00	5 700,00	4 638,46
		meq	300,00	475,00	386,54
		%			16,02
Sodium+Potassiumion,	$(Na^{++}) + (K^+)$	mg/dm³	15,27	70,74	44,22
		meq	664,00	3 075,77	1 922,61
		%			79,68
Dryresidue		mg/dm³	10 700,00	21 500,00	16 769,23
Ph		-	7,31	7,88	7,55
Overallrigidity		meq	364,90	569,76	**490,18**
Waterdensity		g/cm³	1 065,00	1 105,00	**1 085,23**
Watersubgroup		Stronglysalty			
WaterGroup		Brackish			

Table 6 – **The degree of aggressive effect of liquid inorganic media on concrete W4-W12**

Indicatorofaggressiveness	mg/dm³	Grade of concrete	Degree of aggressive action
HydrogenpHindex	7,55	W4	Non - aggressive
	7,55	W6	Non - aggressive
	7,55	W8	Non - aggressive
	7,55	W10-W12	Non - aggressive
Thecontentofmagnesiumsalts	4 638	W4	Highlyaggressive
	4 638	W6	Highlyaggressive
	4 638	W8	Mediumaggressive
	4 638	W10-W12	Mildlyaggressive
The total content of chlorides, sulfates, nitrates, etc. salts	16 733	W4	Mildlyaggressive
	16 733	W6	Non - aggressive
	16 733	W8	Non - aggressive
	16 733	W10-W12	*

Table 7 – **The degree of aggressive action of liquid sulfate media containing bicarbonates for concrete grades of waterproofness W4-W20**

Indicatorofaggressiveness	mg/dm³	Concrete grade	Portland cement according to GOST 10178-85	Portland cement according to GOST 10178-85* and slag-portland cement	Sulfate-resistant cements according to GOST 22266
Contentofsulfates	1 155	W4	Highlyaggressive	Non - aggressive	Non - aggressive
	1 155	W6	Mediumaggressive	Non - aggressive	Non - aggressive
	1 155	W8	Mediumaggressive	Non - aggressive	Non - aggressive
	1 155	W10-W14	Mildlyaggressive	Non - aggressive	Non - aggressive
	1 155	W16-W20	Non - aggressive	Non - aggressive	Non - aggressive

Table 8 – **The degree of aggressive effect of the liquid chloride medium on the reinforcement of reinforced concrete structures made of concrete**

Indicatorofaggressiveness	mg/dm³	waterproof grades of at least W6 at	
		constantimmersion	periodicwetting
Chloridecontent	8 333	Mildlyaggressive	Highlyaggressive

Table 9 – **Corrosion aggressiveness of groundwater in relation to lead and aluminum cable sheathsconcrete structures made of concrete**

Inrelation	pHvalues	Corrosionaggressiveness
to the lead sheath of the cable	7,55	Average
to the aluminum sheath of the cable	7,55	Average

Three layers of specific soils have been identified on the projected site: IGE-1a, IGE-1b and IGE-8.

IGE-1a is a heavy sandy loam, of a solid consistency, calcareous, with the inclusion of gypsum, with interlayers and low-power lenses of sand. The soil is of an average degree of salinity, contains a small amount of organic substances, has slightly wrinkled, slightly swelling and slightly shrinking properties. The type of drawdown is the first. The main normative and calculated characteristics of subsidence and swelling are given below in the form of a table [13]:

Table 10 – **The main normative and calculated characteristics of subsidence**

Sample number	Sampling interval	Natural soil moisture, %	Soil density, g/cm³	Dry soil density, g/cm³	*Relative deformation of subsidence, under load, MPa*				*Initial draw downpressure, MPa*
					0,050	***0,100***	***0,150***	***0,200***	
15	0,20-0,48	26,0	1,42	1,13	0,016	0,019	0,017	0,012	0,05
16	0,50-0,80	28,0	1,84	1,43	0,002	0,003	0,006	0,002	
17	1,0-1,34	31,0	1,65	1,26	0	0	0	0	
116	0,2-0,45	18,0	1,84	1,56	0,024	0,034	0,038	0,042	

Table 11 – **The main normative and calculated characteristics of swelling**

Sample number	Sampling interval	Natural soil moisture, %	Soil density, g/cm³	Density of dry soil, g/cm³	Relative swelling deformation (ews)	Standard swelling pressure, MPa
134	0,2-0,47	19,0	1,82	1,53	0,06	0,05
170	1,0-1,20	20,0	1,61	1,34	0,06	0,05
243	0,5-0,78	19,0	1,79	1,51	0,01	-

IGE-1b is a loamy sludge from dark gray to black in color, fluid consistency, calcareous, with an abundance of whole and broken shells of Cardiumedule, with rotted remnants of seaweed, with the smell of hydrogen sulfide, with layers and low-power lenses of sand. The soil is of medium salinity, contains a small amount of organic substances. Under the influence of dynamic loads, the manifestation of thixotropic properties is possible. According to the totality of physical and mechanical characteristics, it belongs to the group of weak water-saturated clay soils. The main physical, mechanical and chemical characteristics are given below in the form of a table [14]:

Table 12 – **The main physical, mechanical and chemical characteristics**

Soilcharacteristics	Unitofmeasurement	Normativevalue	Calculatedvaluesat	
			0,85	0,95
Naturalsoilmoisture	%	55,0		
Soildensity	g/cm³	1,64	1,52	1,42
Density of dry soil (skeleton)	g/cm³	1,06		
Turnoverrate	d.e	2,016		
Porositycoefficient	.d.e	1,585		
Specificcoupling	kPa	9,81	7,85	6,54
Modulusofgeneraldeformation	MPa	1,7		
Saltcontent	%	3,12		

IGE-8 is a light sandy clay, brown in color, of a firm consistency, calcareous, slightly plastered, of medium salinity. It has swelling properties of a weak degree.

Table 13 – **The main normative and calculated characteristics of swelling**

Sample number	Sampling interval	Natural soil moisture, %	Soil density, g/cm³	Density of dry soil, g/cm³	Relative swelling deformation (ews)	Standard swelling pressure, MPa
58	19,5-19,77	31,0	1,86	1,42	0,07	0,07
131	21,5-21,83	18,0	2,06	1,75	0,04	0,02

Conclusions. When assessing the engineering and geological conditions within the studied area, it is necessary to pay attention to some specific features inherent in the geological environment within it.

The studied territory is part of the Zhylyoysky district of the Atyrau region of the Republic of Kazakhstan and is located within the western part of the industrial zone of

the Tengiz deposit. Tengizchevroil is the owner of the zone within the Tengiz field. P [15].

All lithological-facies groups of soils composing an engineering-geological section to a depth of up to 25 m. - saline, the degree of salinity is average. All lithological-facies groups of soils also contain a significant amount of carbonates and gypsum in their composition.

Loamy silt (IGE-1b), according to the combination of physico-chemical and mechanical characteristics (fluid consistency, high degree of salinity, high degree of compressibility and low strength, the possibility of manifestation of thixotropic properties under dynamic influences), allows this soil to be classified as weak water-saturated clay soils (GOST 25100-2011) [16].

Heavy sandy loam (IGE-1a) and light sandy clay (IGE-8) have swelling properties of a weak degree.

During the production of engineering and geological exploration within the investigated area, all the engineering and geological workings (drilling wells) have opened the groundwater horizon. Chemical analysis of groundwater samples taken within the studied territories showed a high degree of mineralization, groundwater belongs to the brackish group, a subgroup of strongly brackish waters [17].

Dangerous geological processes are characterized by the processes of secondary salinization of soils.

REFERENCES

1 Zeylik B.S., Baratov R.T. How to make Kazakhstan the most competitive and advanced oil country in the world // Oil and Gas. – 2020. – № 3-4. – P. 54-69.

2 Koshim A. G., Sergeyeva A. M., Yegizbayeva A. Impact of the Tengiz oil field on the state of land cover. Quaestiones Geographicae. - 2022. - № 41. – P. 83–93. https://doi.org/10.2478/quageo-2022-0022

3 Zeylik B.S., Nadirov N.K., Sydykov K.Zh. Dynamics of deformation processes in the upper part of the sedimentary cover in the development area of the Tengiz field according to remote sensing data // Oil and gas. – 2013. – №2. – P.. 65-68.

4 Geotechnical investigation report. Tengizchevroil. Northan deastring project. – 2019. – № 2. – P. 8-10.

5 Bondarik G. K.Dynamic and Static Sounding of Soils in Engineering Geology. Published by Jerusalem, Israel Program for Scientific Translations. – 1967, - S. 25-28.

6 GOST19912-2012.Soils. Methods for field CPT and SPT (DPT) sounding.

7 GOST 20522-2012. Soils. Methods of statistical processing of test results.

8 SP RK 2.04-01-2017*. Construction climatology.

9 GOST 21.302-2013. Conventional graphic designations in the documentation on engineering and geological surveys.

10 Bellendir E.N. Accounting for the influence of dynamic influences on the strength characteristics of soils /E.N. Bellendir, V.F.Berzov, V.N. Kutergin // Izvestiya VNIIG im. B.E. Vedeneev. – 2001. – Vol. 239. –P. 143-154

11 Lobkovsky L.I. Technologies of integrated monitoring of water areas in the conditions of oil and gas fields development. Proceedings of the International Symposium "Innovative Technologies in environmental research"RE: 2013 – Research Environments 2013". – M.: Larnaca Cyprus: MIPT, 2013. – P. 24-34.

12 Shiyan L.N., Machekhina K.I., Frantcuzskaia E.O. Groundwater sources in the West Siberian region: Chemical composition, analysis, and water treatment technologies // Cleaner Engineering and Technology. – 2022. – № 7. – P. 41-48, 100441. https://doi.org/10.1016/j.clet.2022.100441

13 Contreras V., Paz P., Netto T.A. Experimental analysis of inorganic scale deposition in pipes: Mesoscale flow loop development and case study // Journal of Petroleum Science and Engineering. – 2022. – № 209. – P. 25-34. https://doi.org/10.1016/j.petrol.2021.109776

14 Yessenamanova M.S., Sangajieva L.K., Yessenamanova Z.S., Tlepbergenova A.E.Migratory activity at the landfill site of microelements of the caspian depression // News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences. – 2020. – № 1(439). – P. 155–163.

15 Author's supervision of the technological scheme for the development of the Tengiz NIPIneftegaz field, Aktau, 2007. – P. 64-69.

16 GOST25100-2011.Soils.Classification.

17 Hamza A.S. and, SayedEl. Coastal Geotechnical Engineering in Practice: Proceedings of theInternational Symposium, Yokohama, Japan, 20-22 Sept. 2000. - Rotterdam,2002. - Vol. 2. - P. 149-162.