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THE METHODOLOGY OF MONITORING THE EARTH SURFACE DISPLACEMENTS DURING THE DEVELOPMENT OF THE SUBSOIL

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Key words: subsidence, monitoring, geodinmichesky phenomena, vertical movements of a terrestrial surface.

Annotation. The results of studies were summarized in the article, which conducted by the authors in the course of carrying out scientific studies on the vertical movements of the earth's surface under the influence of the development of the Tengiz field.

Introduction. The subsoil of the western region of the Republic of Kazakhstan is rich by hydrocarbon fields. A large scale development of oil and gas resources, leads to intense movements of the earth's surface, both within the local area, and in the individual structural elements, resulting in bending occur boreholes tear gas and water pipelines, disabling the railways and roads, underground utilities and engineering structures, which in turn leads to a considerable economic loss. All this is a direct consequence of the change of the geodynamic regime of the geological environment under the influence of large-scale development of the subsoil, which conclusively proved by the results of experimental studies of the motion of the Earth's surface by the example of nature-technological system "Caspian zone."

Main content. For safe and efficient oil and gas development is necessary to investigate the impact of natural and anthropogenic factors on the development of deformation processes that will assess the possibility of controlling their effects on the rock mass, the earth's surface and engineering facilities. There is also the unsolved question of operational monitoring of ground deformation, processing and analysis of the received information. Therefore, one of the actual problems of intensive mining, especially in seismically active regions, is the study technological movements of the earth's surface. Various conditions of occurrence of oil reservoirs, their sizes and shapes, as well as the technological features of conducting mining operations require individual, technical solutions based mining subsoil protection, environmental protection and industrial safety.

Currently accumulated extensive material for traffic on earth, both within the local areas - geodynamic polygons (GFC) and over large areas. In most cases, GFC observations are complex: at the same time to study the motion of the Earth's surface and conducted a wide range of geological, geomorphological, geophysical, seismological and geodetic studies mainly, the possibility of deformation of the earth's surface caused by the engineering activities of people (technological movement).

For a correct prediction of subsidence over the earth surface (SES) and the adoption of appropriate measures to prevent the harmful effects of oil and gas, it is necessary to know the technological component of the total amount of vertical SES, or measures to prevent subsidence of these lead to unnecessary material costs and will be ineffective. In this regard, the special importance of reliable and timely forecast technological SES, which is understood scientifically based judgments about possible states of the object in space and time.

Research in the field of study of the motion of the earth's surface in large-scale oil and gas development based on many scientific research organizations and individual researchers [1-10]. However, despite some progress in addressing changes in geodynamic regime of the geological environment for large scale development of mineral resources, some questions remain insufficiently studied.

At the present stage of development of applied geodesy no scientifically based methodology for monitoring land surface deformations developed oil and gas fields. Regulatory framework is also missing. Traditionally used scheme in such work is thickening of the state geodetic network in the area of oil and gas lines, leveling of class II. In this calculation is not carried out the required measurement accuracy is not justified by the required frequency of observations, not a principle of reasonable minimum amount pledged survey markers within the area of potential subsidence. In connection with this unnecessarily increases the cost price of the work and informative study is lost.

Thus, the organization of monitoring the movement of the earth's surface (MES) in the area of oil and gas experience the following specific requirements:

1) improving the information content of the results;

2) increasing the efficiency of observations;

3) cost-effectiveness of research.

It was our main aim of our research.

Kazakh National Technical University made theoretical and experimental surveyor - geodetic research examining the movements of the earth's surface in the Tengiz and Botakhan.

Abnormally high reservoir pressure, complex geological structure, as well as a significant field life with ever increasing volumes of recoverable oil yield suggests the possible drawdown of anthropogenic origin, and that was the basis for this study.

In solving the problem of determining the technological SES along with geodetic methods widely used methods of theoretical calculations of SES. In determining the SES caused oil and gas extraction, solves two problems: the calculation of sedimentation seam roof (SSR) and the calculation of the PCR from the known value of SSR.

The accuracy of the calculated value of the SES depends on the accuracy of the calculation of the vertical compression of the skeleton oil reservoir (or subsidence seam roof). The results of theoretical calculation of anthropogenic SES give less accurate results than the actual repeated geodetic measurements. However, it seems promising to use them both at the design stage of geodynamic polygon (GP), so to compare the calculated values of the SES with the same values obtained by re-leveling.

State oil and gas reservoir in the process of its development depends on natural and anthropogenic factors. Natural factors include the geological features of the structure and properties of petroleum reservoir rock from which the reservoir is. Among the technological factors include: the ways of placing production and injection wells, the rate of production and injection fluids, and others.

In this regard, besides the Tengiz and Botakhan also just studied a number of oil fields in Kazakhstan sector of the Caspian Sea. Areas of development of many fields are located in areas with intense tectonic movements. According to the geological documentation and field observations identified the main characteristics of tectonic disturbances.

Efficiency and safety of mining operations during extraction of minerals, also during exploitation of facilities, which are placed in the operations site of these actions, depends on geodynamic state of thickness of minerals and tectonic and techno genic processes occurring in those minerals. Meanwhile, projection of mining companies are usually based on poor information about the state of rock mass, because it is impossible to make observations on the construction site of future facility before the beginning of mining operations.

These problems and complications are dealt with the assistance of geodynamic monitoring, the main goal of which is obtaining operative information about geomechanical processes and consequences caused by them occurring in the earth formation and earth surface, which are needed for taking well-timed preventive measures.

According to the regulation about the geological and surveying provision of industrial safety and protection of natural resources in the Law of natural resources and their usage №2828, Law about the natural and techno genic emergencies, Regulation about Governmental monitoring of natural resources of Republic of Kazakhstan, functions of surveying service include monitoring of natural resources, including processes of rock mass and earth surface movements, geomechanical and geodynamic processes in natural resources usage to prevent deleterious effect of mining operations on capital mining operations site, surface facilities and environment.

Based on the analysis of geology and tectonics of region, numerical modelling and experimental evaluation of the state of strain in the massive, energetically loaded zones could be pointed out, which determine boundaries of geodynamic monitoring zones. Afterwards, monitoring of danger zone is done, which mainly includes control of deformation and parameters of geophysical fields.

Reliable information about deformations of rock mass could be obtained through direct geodetic observations on geodynamic polygons. Earth surface movements(ESM) are learnt through method of repetitive leveling based on first class technique, when measurements of excess in sections between adjacent frames are analyzed. Technology of leveling must correspond to requirements of accepted technique.

The expected structure of learning technique and prediction of dangerous states in PTS considering the whole complex of geophysical and geodetic measurements and their joint processing are represented on Figure 1.

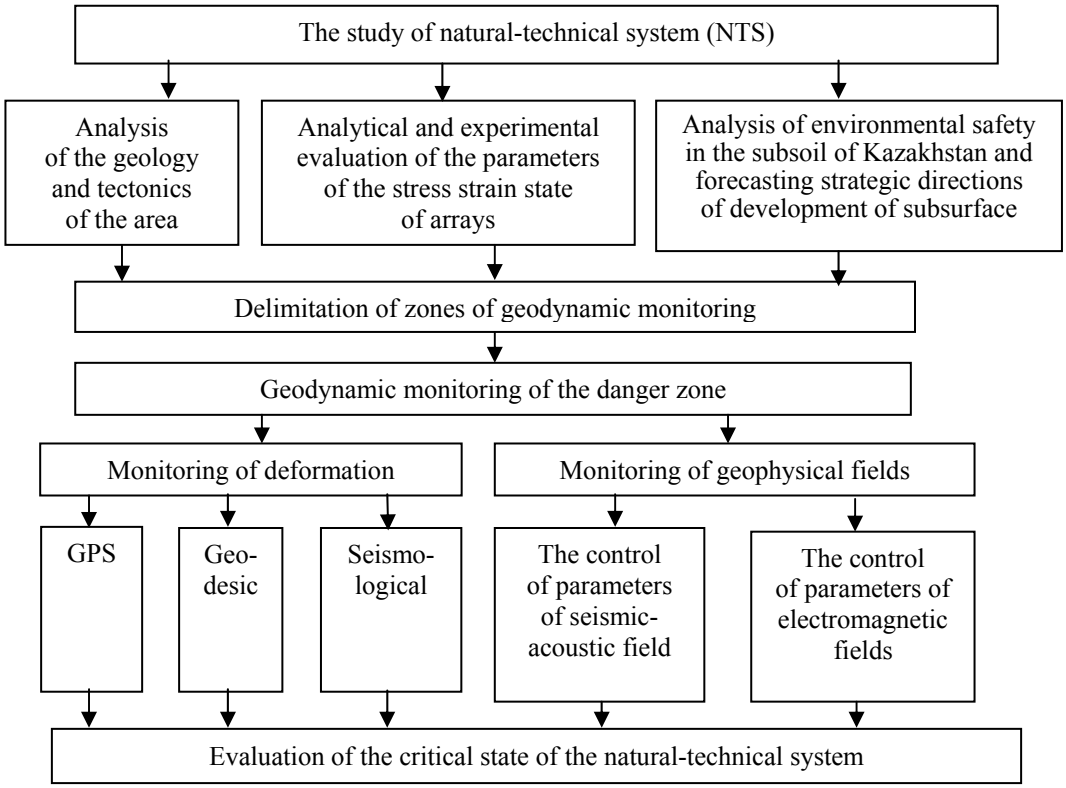

Figure 1 – Scheme of learning method and prediction of geodynamic processes in NTS

Analysis of materials devoted to the study of the SES developed oil and gas fields, showed that the use of repeated leveling by trunk moves leveling HHS can not get enough information about vertical movements of the earth's surface (VMES) deposits. The scheme of special geodetic constructions planned on the GFC not always lead to the desired result, particularly in areas that coincide with areas prone to active anthropogenic influence, where there is a problem common VMES division into separate components.

In order to study technogene phenomena, and seismotectonic movements earth's surface, caused by the development of mineral resources, the management of "TCO" decided to resume in this area surveillance array. In this regard, after a detailed geological, geodetic surveying-study areas and technological parameters of the Tengiz field was recreated geodynamic polygon by the proposed technique by us in 2005, placing a quadrilateral polygon in the center of the expected displacement trough with radial profile lines within the deposit.

Given that the primary major faults Caspian region have the latitude, profile lines were mainly oriented meridionally. Tengiz GFC consists mainly of seven specialized lines, as well as additional

leveling networks of about 1,000 points, including 5-fundamental, 20- (reference and working) GPS network, 5-seismological, 5- light ranging and 10- deep. At 407 points set security labels [11].

Long-term observation of deformations over 1000 benchmarks GFC showed the complexity of the field work, especially the transfer from one point to another set of devices (the device itself, stand, rack, etc.. In this regard, developed the device circuit is shown (Figure 2), where the upper part of the center is equipped with forced centering table, for the installation of instruments and measuring the efficiency of operations. The invention relates to a geodetic center for installation of new devices and signals. Such items on GFC Tengiz-25 pieces. The purpose of the invention - to increase the accuracy of centering, speed measurement without using a tripod in points standing and watching. The new device allows fast and precise alignment, and eliminates the use of tripods.

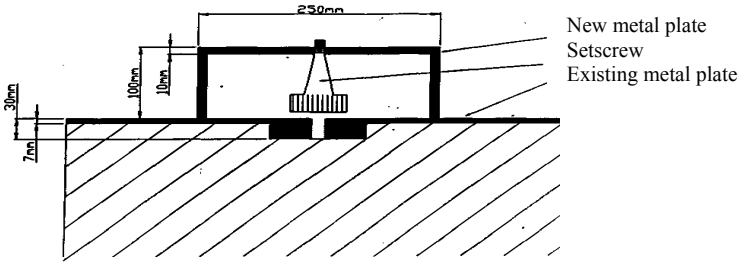

Figure 2 – New installation for appliances

In the study of modern movements of the earth's surface of the vertical component is determined based on the results of repeated precision leveling. At GFC "Tengiz" leveling class II- produces digital laser level firm Leika WILD NA 3003 with invar strips by the method of double leveling in the forward and reverse direction. For leveling accuracy tolerance was set ±0,4 mm, which corresponds to the leveling tolerances I - class [12].

The principle of leveling is based on processing the encoded signal (obtained from the rack), and then send the data to the computer and processing of a special program. The advantage of this system is the ease of measurement, no error with reading and writing, automatic calculation of height during the measurement and data logging.

Included in the GFC "Tengiz" points form a framework region network. On these points was organized geodynamic monitoring of the condition of pipelines and engineering structures.

The observations were made by three satellite receiver GPS, which allowed to measure in some areas three vectors at the same time. Processing of satellite observations are made with a special program that is included with satellite receivers, the result will be horizontal coordinates of all points of the network and elevations.

To assess emerging and developing at GFC ground deformation we analyzed the horizontal and vertical displacements 9 working points of the pipeline profile line. Stage coordinates of points determined from satellite measurements.

To analyze the accuracy of measurements made satellite receiver GPS, measurements were made of the control network of precision electronic tachometer TS 1200. The circuit control network is a geodesic quadrangles with measurements of angles and distances. Comparative analysis of the measurements (Table I) showed the accuracy of satellite measurements practically coincides with the total station measurement accuracy.

Thus, development of geodynamic polygon's network for precise observations using electric and satellite GPS receivers allowed to decrease time spent on determining coordinates in recalculation of one point 10-15 times and increase accuracy of determining coordinates at least 2 times.

In Figure 3 is shown a graph of displacement of benchmarks leveling network GFC "Tengiz" for the period 2001-2005 and 1992-2008. 1-3 on a profile consisting of 25 benckmarks. In the period of 2001-2005. benchmark had a displacement of 2 mm to 8 mm., and for the period 1992-200. $\eta_{max} = 2,9$ cm.

Thus, the organization of further research organization deserves greater attention on GFC geodetic monitoring, based on the use of satellite methods in those areas of engineering structures on the territory of the Tengiz field, which are subject to technogenic processes [13, 14].

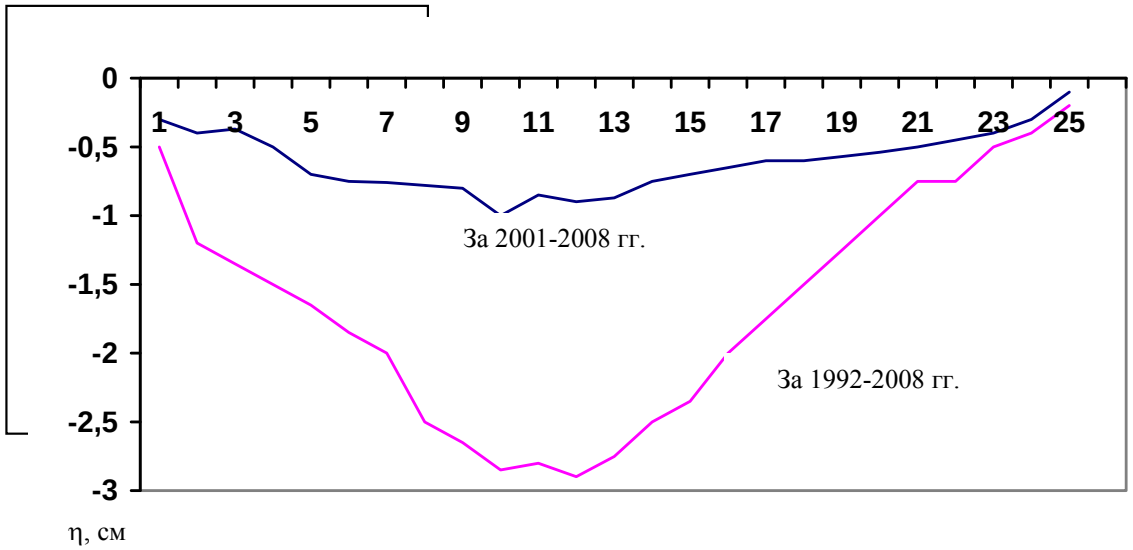

Figure 3 – Chart of dislocation of frames by profile 1-3.

Afterwards, all information on legitimacy of process of system displacements and parameters of critical condition proceeds into expert system, where assessment of natural-technical system(NTS) is done on the basis of integration of database and knowledge, and justified by appropriate management decisions. Final goal of these decisions is to provide either adapting functioning of NTS or controlled withdrawal of its critical state.

Conclusions. Analysis of results of monitoring of the earth surface displacements that occurred over the Tengiz field from 2001 to 2008 and registered in the processing of observational data showed the presence of accelerating time-subsidence surface. Geodetic measurements are discrete, they do not provide a complete picture of the deformation processes in time. This can only be done with comprehensive research, including seismological, geophysical methods, and space radar monitoring of displacements.

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ЖЕР ҚОЙНАУЫН ЗЕРТТЕУДЕГІ ЖЕР БЕТІ ЖЫЛЖУЛАРЫНЫҢ МОНИТОРИНГІН ЖҮРГІЗУ ТӘСІЛДЕРІ

М. Б. Нұрпейісова, Г. М. Қырғызбаева, О. А. Сарыбаев, Ш. К. Айтқазинова

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Тірек сөздер: шөгу, мониторинг, геодинамикалық құбылыстар жер бетінің вертикаль жылжулары.

Аннотация. Мақалада Теңіз кен орынында жер бетінің вертикаль жылжуларын зерделуеудің жүргізілген ғылыми жұмыстардың нәтижелері келтіріген.

МЕТОДИКА ВЕДЕНИЯ МОНИТОРИНГА СМЕЩЕНИЙ ЗЕМНОЙ ПОВЕРХНОСТИ ПРИ ОСВОЕНИИ НЕДР

М. Б. Нурпеисова, Г. М. Кыргизбаева, О. А. Сарыбаев, Ш. К. Айтказинова

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Ключевые слова: оседание, мониторинг, геодинамические явления, вертикальные движения земной поверхности.

Аннотация. В статье подведены результаты исследований, проведенных авторами в процессе выполнения научных работ по изучению вертикальных движений земной поверхности под влиянием освоения месторождения Тенгиз.

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