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RESEARCH INTO THE RADIONUCLIDE POLLUTION OF ECOSYSTEM ON THE TERRITORY OF OIL FIELDS OF ABSHERON PENINSULA

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Samples of produced water, solid rock and sediments were analysed to assess the impact of oil and gas fields development on radionuclide pollution of ecosystem in Absheron peninsula. The studies revealed technogenic anomalies on the territory of oil fields. Laboratory analyses found that as a result of oil industrial activities the ecosystem on the sites in question are polluted with naturally occurring radionuclides – K, U (Ra) and Th. Research revealed technogenic radioactive anomaslies on some sites of oilfield territories. Increased levels of U, Th, Ra and Sr were detected in the produced waters of offshore and onshore oil fields.
Keywords: *radionuclides, produced water, sediment, rock, crude oil*

INTRODUCTION

Most of industrial activities, including oil-gas, power engineering and metallurgy are the reasons of radioactive pollution of the environment. Radioactive pollutants have natural and technogenic origins. Radium (Ra), thorium (Th), strontium (Sr), uranium (U) and potassium (K) are the most widespread pollutants among the naturally-occurring radionuclides. Following various technogenic processes, the naturally-occuring radionuclides can become serious threat to ecosystem.

Hence, many indistrial enterprises dealing with the processing of radioactive compounds containing materials cause serious hazard for all ecosystem components, including human health. All the activities associated with both the extraction and use of conventional fuel are potential sources of radionuclide pollution.

From the very outset of the 20 century, the impact of oil-gas industry on the radionucide pollution of the environment has been investigated in hydrocarbon bearing regions throughout the world including the USA (Alaska and Mexican Gulf), North Sea, Canada, Australia, Egypt and Saudi Arabia [1-6].

Studies showed that significant quantity of radioactive elements was accumulated in the areas close to oil wells and transport pipelines. Main sources of radioactive pollution are crude oil, produced water and solid rocks. Produced waters contain some natural radioactive substances, particularly ^{226}Ra and ^{228}Ra decayed from natural radionuclides - U and Th which solid rocks contain. Research of some authors confirmed that following the natural decay of U and Th a number of other radionuclides such as Bi -212, Bi-214, Ac-228, Pb-210, Pb-212 and Pb-214 can be found in produced waters. However, the environmental impact of these radionuclides is insignificant as compared to Ra because of their low activity in ecosystem [7-10].

In Azerbaijan, studies into the radionuclide content of crude oil date to 50-60 years of the last century. Analysis of the literature information confirms the presence of U, Th and Ra in crude oil and produced waters. Studies revealed that the concentration of U in methane-naphtene fraction of oil is higher than in paraffin-aromatic fraction. The content of produced waters in the Absheron oil fields changes from chloride salts containing hard water of the upper productive layers into chloride-carbonate containing water of deep layers depending on the well depth. Results of

researches indicate that Ra and U pollution is mainly observed in highly mineralized sulphate free waters of the upper productive layers [11, 12].

Subsequent work was carried out to assess the radionuclide pollution on the territory of oil-gas fields. Studies found a considerable quantity of radionuclides in soils, surface waters and bottom sediments of oil contaminated areas. Increased radiation levels were measured on some of oil collecting sites and oil-gas fields [13-16].

The paper introduces results of studies into radionuclide pollution of the environment on the territory of the Absheron oil fields.

MATERIALS AND METHODS

Produced water, sediment and ground (rock) samples were analyzed to assess the radionuclide pollution on the territory of oil fields. Sites in question were chosen on the territory of Bibiheybat and Zykh-Hovsan oil fields of Absheron peninsula.

10 ground samples were collected out of two sampling wells dug to study the radionuclide content of rocks. The depth of sampling for chemical analysis ranged from 0.2 to 6.0 m. Sediment samples were collected from different parts of Zykh-Hovsan site. The data considered here are the results obtained from 6 sampling points as follows: sample 1 from the centre of Zykh lake, samples 2 and 3 from Duzlu lake and three samples from surface runoffs.

Produced water samples were collected out of onshore and offshore locations on the territory of Bibiheybat field. The data presented in the paper are values of the analysis of at least 5 offshore and 5 onshore samples.

The samples were analyzed using gamma-spectrometer according to generally accepted methods for the assessment of contribution of each element into radionuclide pollution.

RESULTS AND DISCUSSION

The data derived from rock analysis are given in Table 1. As can be seen from the table, the specific activity of upper layers varies within a range of 14 to 105 Bk/kg that is typical for soils and sedimentary rocks. The presence of U(Ra) was ovserved in all samples. In some samples of the locations characterised by radioactive anomalies the concentration of U(Ra) exceeded the limits of typical range –11-52 Bk/kg reaching 96.7 Bk/kg. In the well № 1, the radioactive anomaly was observed at a depth of 4.6 m, whereas, in the well № 2 the radioactive anomaly was recorded at a depth of 1.0 m. The data in Table 1 indicate that in the well № 2 the concentration of U(Ra) decreases slowly from 96.7 to 33.5 beginning from a depth of 1.0 to 6.0 m. This is an evidence to U(Ra) migration from upper layers as a result of technogenic impact. It should be noted that no uranium pollution was detected at 0.2 and 0.7m depths of this well

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Table 1. Concentration of radionuclides in the rock samples on the area of oil fields

Samples	Depth, m	Aktivity, Bk/kg	Concentration of radionuclides, Bk/kg		
			U(Ra)	Th	K
Well № 1					
1	0.5	67.0	57.8	ND*	155.5
2	1.0	33.5	0.15	6.1	322
3	2.0	23.5	0.4	7.5	164.8
4	4.6	150.6	89.2	18.94	467.3

5	5.0	31.7	ND	8.7	258.8
Well № 2					
1	0.2	25.0	ND	1.6	301.9
2	0.7	33.9	ND	7.4	308.8
3	1.0	105.7	96.7	ND	115.4
4	1.5	102.1	86.8	ND	195.1
5	6.0	52.7	33.5	ND	245.2

Note: ND*- compound not detected or below instrumental direction limits

Results of analyses revealed that the main element defining the radioactivity of the study site was ^{40}K that had been detected in all rock samples varying from 115.4 to 467.3 Bk/kg.

Table 2 shows the results of analysis into radioactive pollution of surface water sediments of the site. As is seen from the Table, the content of radionuclides in the sediments of surface runoffs exceeded the typical activity range to some extent during the studies. But it is worth to note that the content of radionuclides in such mobile systems is also dependent on climatic factors. In the period of rainfall the radionuclide content of surface runoffs may decrease.

Table 2. Concentration of radionuclides in the bottom sediments of surface waters

Samplies	Activity, Bk/l	Concentration of radionuclides, Bk/l		
		U(Ra)	Th	K
1	9.79	7.69	ND	26.1
2	11.89	ND	ND	151.6
3	90.62	57.41	13.71	194.5
4	79.70	62.09	6.54	116.0
5	80.40	67.25	4.80	87.5
6	114.94	101.07	ND	176.8

Researches carried out to study the radioactive elements' distribution in produced waters confirmed high concentrations of U, Ra, Th and Sr in produced waters during offshore and onshore oil production. The average values of analyses of the samples collected from onshore and offshore stations are given in Fig. 1.

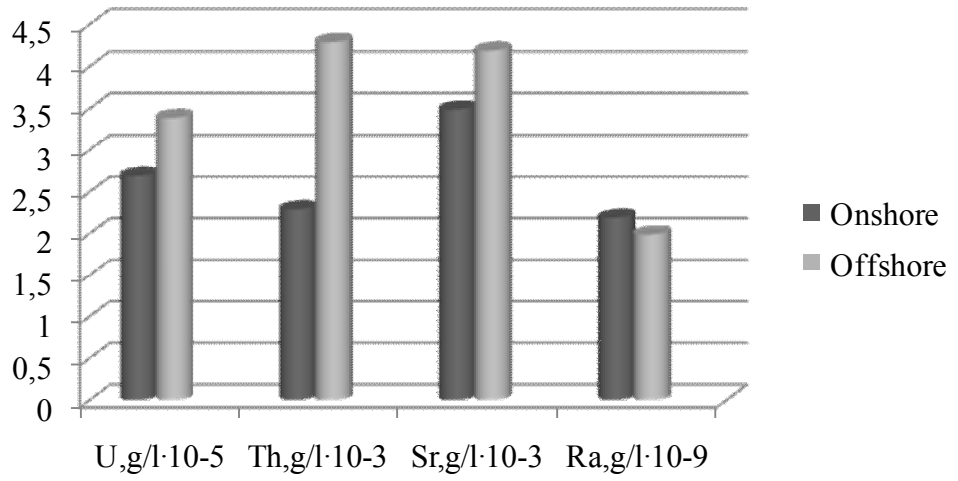

Fig. 1. The quantity of radioactive elements in the produced waters of onshore and offshore oil fields

CONCLUSIONS

Proceeding from the results above, it can be concluded that during the development of hydrocarbon resources the main sources of radioactive pollution are crude oil, produced water and solid rocks. High concentrations of U, Ra, Th and Sr are detected in produced waters of offshore and onshore oil production. Analyses showed that sediments of surface waters under study site are subject to radioactive pollution. Several technogenic anomalies were revealed in the area of oil fields. Overall, the results derived from this study found that regular radio-ecological monitoring should be implemented on the territories of the Absheron oil fields to prevent radiation danger.

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ABŞERON YARIMADASININ NEFT-QAZ YATAQLARI ƏRAZİSİNDƏ EKOSİSTEMİN RADİONUKLİDLƏRLƏ ÇİRKLƏNMƏSİNİN TƏDQİQİ

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Abşeron yarımadasında neft-qaz yataqlarının işlənməsi ilə əlaqədar olaraq ekosistemin radionuklidlərlə çirklənməsinin qiymətləndirilməsi məqsədilə lay suları, bərk suxur və çöküntü nümunələri analiz olunmuşdur. Laboratoriya analizləri neft sənaye müəssisələrinin fəaliyyətinin tədqiq olunan ərazidə ekosistemin K, U (Ra) və Th kimi təbii radionuklidlərlə çirklənməsinə səbəb olduğunu göstərir. Tədqiqat nəticəsində neft yataqları ərazisinin bəzi hissələrində texnogen radioaktiv anomaliyalar aşkar olunmuşdur. Quruda və dənizdə neftçıxarma zamanı alınan lay sularında U, Th, Ra və Sr-un yüksək miqdarı qeydə alınmışdır.
Açar sözlər: *radionuklid, lay suları, dib çöküntüsü, suxur, xam neft.*

ИССЛЕДОВАНИЕ ЗАГРЯЗНЕНИЯ ЭКОСИСТЕМЫ РАДИОНУКЛИДАМИ НА ТЕРРИТОРИИ НЕФТЕГАЗОВЫХ МЕСТОРОЖДЕНИЙ АБШЕРОНСКОГО ПОЛУОСТРОВА

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Образцы пород, донных отложений и пластовых вод были анализированы для оценки загрязнения экосистемы радионуклидами на Абшеронском полуострове в связи с разработкой нефтегазовых месторождений. Лабораторные анализы показали, что в результате деятельности нефтепромыслов экосистема исследуемой территории загрязняется такими радионуклидами как K, U (Ra) и Th. Исследования выявили техногенные радиоактивные аномалии на некоторых участках территории нефтяных месторождений. Повышенные концентрации U, Th, Ra и Sr были обнаружены в пластовых водах, полученных во время нефтедобычи на суше и морских месторождениях.
Ключевые слова: *радионуклиды, пластовые воды, донные отложения, порода, сырая нефть.*

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