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The Impact of Water Resulting from Oil Extraction on Marine Environmental Pollution Surrounding the Bouri Oil Field with Radioactive Materials

تأثير المياه الناتجة عن استخراج النفط على تلوث البيئة البحرية المحيطة بحقل البوري النفطي بالمواد المشعة

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Summary

Usually, quantities of radioactive elements remain with the accompanying oil and water. Through the results of this study, we find that the concentrations of the radioactive elements bismuth and thallium are higher than the recommended threshold values in all the samples studied, which recommended concentrations of (0.02), (0.01) Becquerel, as they were recorded in the surrounding water (0.028651) and (0.03263) Becquerel, respectively .The study recorded that the concentration of lead was higher than the permissible limits in all the samples studied, which set the standard (0.03), Becquerel, while the accompanying water recorded a concentration of (0.0651), while we find that the study showed that the concentrations of cadmium, palladium, and potassium were less than the permissible limits. The study showed high concentrations of both actinium and tungsten in the surrounding waters and the accompanying uranium (0.0331),

(0.06059), and (0.11948) Becquerel's, respectively. From these results, it can be concluded that the extraction, transportation, and refining of petroleum has an important impact on the marine environment and the quality of coastal waters, and this has been reflected in This impacts the increasing levels of heavy metals and petroleum hydrocarbons on the environment surrounding the Al-Bury field platform and the beaches of the Zwara city

Keywords: **Zwara coasts**, **oil pollution**, **Al-Bouri field**, **associated waters**

ملخص

عادة ما تبقى كميات من العناصر المشعة مع الزيت والماء الناتجة، ومن خلال نتائج هذه الدراسة نجد أن تراكيز العناصر المشعة البزموت والثاليوم أعلى من قيم العتبة الموصى بها في جميع العينات المدروسة والتي أوصت بتركيزات (0.02) و(0.01) بيكريل كما سجلت في المياه المحيطة (0.028651) و(0.03263) بيكريل على التوالي، كما سجلت الدراسة أن تركيز الرصاص أعلى من الحدود المسموح بها في جميع العينات المدروسة والتي حددت المعيار (0.03) بيكريل بينما سجلت المياه المصاحبة تركيز (0.0651)، بينما نجد أن الدراسة أظهرت أن تراكيز الكادميوم والبلاديوم والبوتاسيوم كانت أقل من الحدود المسموح بها.

وأظهرت الدراسة ارتفاع تراكيز كل من الأكتينيوم والتنجستن في المياه المحيطة واليورانيوم المصاحب (0.0331) و(0.06059) و(0.11948) بيكريل على التوالي، ومن هذه النتائج يمكن الاستنتاج أن استخراج ونقل وتكرير البترول له تأثير مهم على البيئة البحرية ونوعية المياه الساحلية، وقد انعكس ذلك في زيادة مستويات المعادن الثقيلة والهيدروكربونات البترولية على البيئة المحيطة بمنصة حقل البوري وشواطئ مدينة زوارة

الكلمات المفتاحية: سواحل زوارة، التلوث النفطي، حقل البوري، المياه المرتبطة.

Introduction

Radioactive heavy metals are considered serious environmental pollutants that significantly affect the marine environment and human health (Järup, 2003). Heavy metals may accumulate in the marine environment through several pathways, such as leakage from industrial and agricultural sources, and atmospheric precipitation (Nriagu, 1996). This accumulation leads to negative impacts on marine ecosystems, as increased concentrations of heavy metals in marine waters lead to the death of marine organisms and habitat degradation, affecting the ecological balance (McCarthy & Smith, 2018).

Radioactive heavy elements pose a major risk to human health due to their accumulation in marine food chains. Exposure to these elements can lead to a range

of serious health problems: Heavy elements such as lead and cadmium can cause acute or chronic poisoning, leading to problems with the nervous system and kidneys (Agency for Toxic Substances and Disease Registry, 2007).

Some heavy metals may affect the respiratory system and cause chronic diseases (Environmental Protection Agency, 2016). There is an association between exposure to certain heavy elements such as uranium and thallium and an increased risk of cancer (Bleise *et al.*, 2003).

Previous studies

A study (Al-Muqri 2009) indicated that the water produced from the fields belonging to the Arabian Gulf Oil Company ranged between 3227.7 and 58018.5 cubic meters/day. The results related to the quality of the water extracted from the Hamada field also indicate that the degree of interaction of this water is approximately equal, while the degree of conductivity The electrophoresis ranged between 2.06 - 2.67 dS/m, and it is generally considered to have medium salinity, and its heavy metal and total hydrocarbon content did not exceed the limits that are not permissible for irrigation.

Al-Haddad *et al.* (2013) studied the level of pollutants in the western Libyan coastal waters. It was concluded that the conditions of the marine environment in the Libyan coastal waters were affected by various types of marine pollution resulting from their proximity to sources of industrial and municipal waste pollution. It was found that the petroleum industry has a significant impact on the marine environment.it is the main source of heavy metals and petroleum hydrocarbons, can be managed through governmental and social legislation of the Libyan state.

Al-Saidi's study (2015) aimed to identify the extent of groundwater contamination of wells adjacent to gas stations with petroleum derivatives due to oil spills resulting from the collapse of these tanks in the Fezzan regions of southern Libya. The results showed that the concentrations of hydrocarbon compounds in water samples taken from wells in the region ranged between 0 - 127.4 mg. /liter. As for the concentration of petroleum hydrocarbon compounds in the water taken from the sewage tanks of gas stations, it ranged between 20 - 254 mg/L, where the highest

concentration in those tanks was in the sewage tank of Qaraqra gas station, while the lowest concentration was in the sewage tank of Al-Obeid gas station

The study of Al-Haddad *et al.* (2016) recorded that the beaches of the city of Zwara were affected by high concentrations of some heavy metals, which include lead, chromium, nickel, and cadmium, which are the most dangerous in the Libyan marine environment, and that their concentrations in the waters are higher than the threshold values of UNESCO (1978).

The results of the study by Amhani *et al.* (2022) showed that leaks and attacks on oil and gas tanks and transmission lines are among the most dangerous threats to the environment and health if safety controls are not observed. Crude oil contains toxic substances such as sulfur, lead, and others, and these substances pose a major threat to the environment in production, refining, and distribution areas.

As well as across various transportation lines. Therefore, the study recommended that a detailed environmental impact assessment be conducted before starting any oil operations activities.

Al-Taweel's study (2023) focused on the effects resulting from the leakage and combustion of crude oil in some Libyan oil facilities and oil and gas transportation lines and the impact of oil pollutants in surface and groundwater and in the human respiratory system. The study concluded that the Libyan environment was affected by the operations of the oil and gas industry, which contributed to the pollution of various elements of the environment (water, air, and soil), through the drilling of oil wells, whether exploratory or productive, and the water, mud, acids, and various chemicals that were left behind that could leak or mix with the elements. The environment is polluted،

In the study of Al-Arabi Nour Al-Huda (2024), the results of analyzes of the water associated with oil for the Yamama Formation in the North Rumaila field were calculated, its type and classification were determined, and the quality of the reservoir was evaluated using well sensors by dividing the formation into several units according to petro physical characteristics, building a three-dimensional model of porosity and water saturation, and petrographic analysis of the formation. Al-Yamama using rock fragments and identifying the most important digenetic

processes affecting the formation, as well as determining the depositional environment.

Abdul Hussein's study (2024) aimed to treat the produced water from the Middle Oil Company using coagulation, sedimentation, precipitation, and advanced oxidation processes to remove total dissolved solids and oil content from the produced water, and to obtain the best conditions for advanced oxidation processes. Several traditional physical, chemical, and even biological treatment processes were tested. To be reprocessed The study found that oil removal reached 86% when using ferric sulphate at 30 mg/L and polyacrylamide at 2.5 mg/L, while the oil removal rate reached 84.4% when using klaraid CDP1326 at 60 mg/L and polyacrylamide at 2.5 mg/L. At pH = 6.86 and room temperature, various advanced oxidation processes (photo Fenton process, Fenton process, photo catalytic and photolysis) were studied.

The practical study

Study area

The Al-Bouri oil field platform is located north of Zwara on the shore of the Mediterranean Sea as shown in Figure No. (1). The city of Zwara is about 120 km west of the capital, Tripoli, and 60 km away from the borders of Tunis. With a population of 45,000 people, the Albury oil field is the largest off shore field in Libya, and it is managed by the Mellitah Oil and Gas Company, which is a joint venture between Italy's ENI and the National Oil Corporation. The Albury oil rig produces about 40,000 barrels per day, and includes 38 wells for the field that currently pumps 37,914 barrels per day Of these, 21,940 barrels per day come from the main platform. (Alhaddad *et al* .,2013).

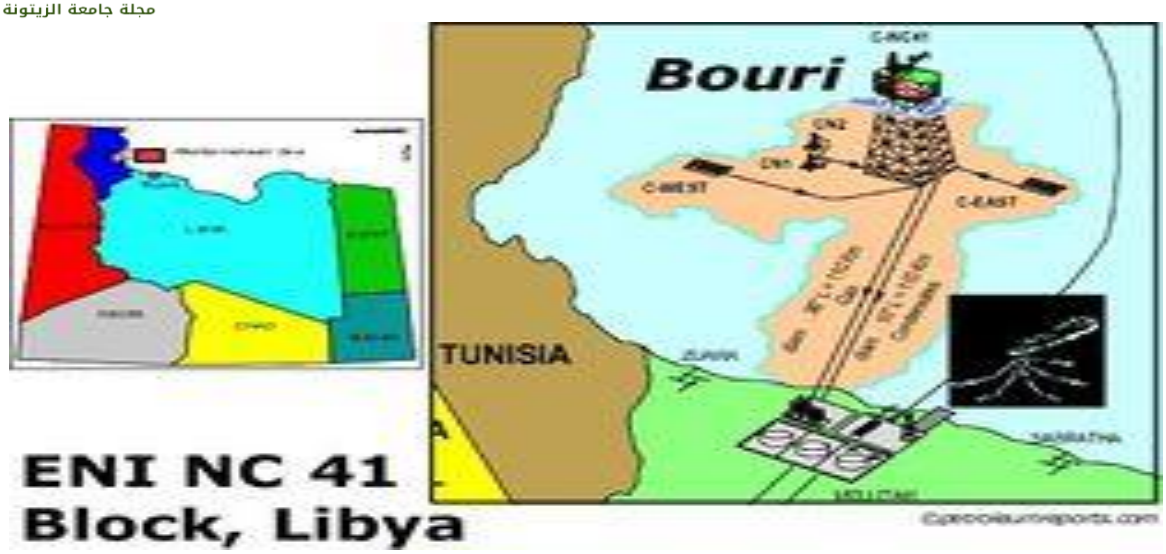

Figure No. (1) **Map shows The Al-Bouri oil field platform**

2.2 Sample collection methods

Samples were collected from the oil extracted, from the water accompanying oil, from the waters surrounding the Al-Bouri field and from the coastal waters of Zwara in two-liter plastic bottles after being washed well with distilled water containing (1.5 ml) of nitric acid as a center for preserving samples. Where (3) samples were taken with (3) replicates and were saved by crushed ice in a container and then transferred to the laboratory for the required chemical analyzes.

Methods used in measurement

Electrical conductivity (**EC**, **ds** / **m** '): the conductivity of water samples was measured directly after the samples were collected using a conductivity device (431) Conductivity meter , model.

pH measurement: The pH was measured immediately after sample collection with a device pH Meter model 3310).

Measurement of radioactivity:

The radioactivity of these samples was measured using a high-purity gamma spectrometer (H P G e) after the required calibration of the device was performed before measuring the samples. Radioactivity was calculated through the following equation: (A = CR / Y × Eff × V).

Efficiency factor, Eff, counting rate per second CR, permittivity of element Y, radioactivity A, where:-

V, sample size.

The results were analyzed statistically using ANOVA and Tukey Test .

Results and discussion

Hydrogen Number: (pH)

pH reflects the activity of hydrogen ions in water, and is the negative decimal logarithm of the hydrogen ion concentration. It is expressed in numbers from 0 to 14, where numbers less than 7 indicate that the water is acidic, and numbers greater than 7 indicate that the water is basic at 25 degrees Celsius. (Al-Shallaf and Imad 1998)The amounts of radium present in the producing waters accompanying oil depend on the nature, quantity, and content of these rocks Uranium and thorium, in addition to the physical and chemical conditions present in them, such as pressure, temperature, and (pH) Through the results, as shown in Figure No. (2), we find that the average pH concentration in the surrounding and accompanying waters and the beaches of the city of Zwara ranged between (6.37-8.4), which is within the permissible standards recommended by (10) according to the Egyptian standard for discharging polluted water in Coastal areas (1994)

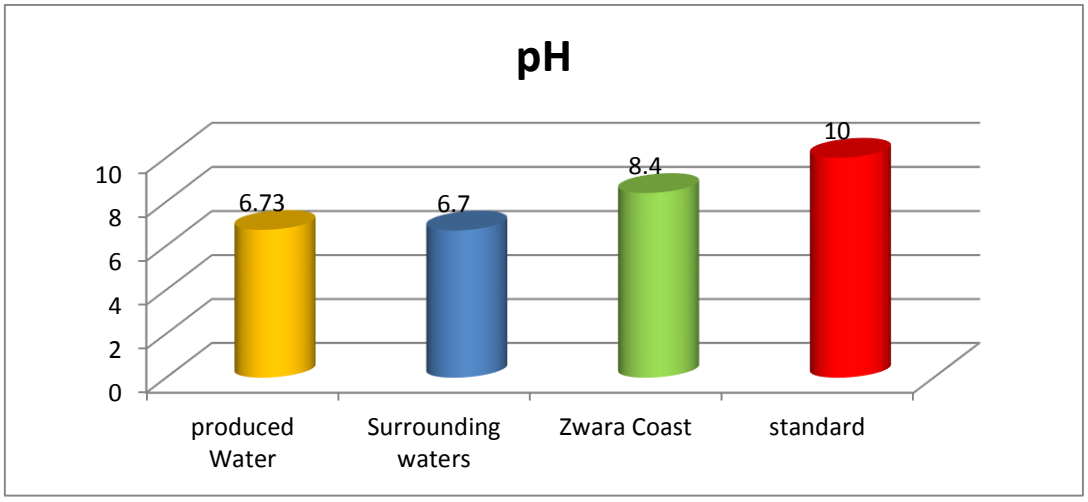

Figure No. (2) shows the pH concentration in the studied samples

Electrical conductivity

Electrical conductivity is a numerical term for the ability of a solution to carry electric current and depends on salinity rates. Salinity represents the important environmental factor that causes varying effects on the life of marine organisms, which in turn represents an important factor in limiting the distribution of many marine organisms (Islam Ahmed 1995).

Through the results, as shown in Figure No. (3), we find that the degree of conductivity in the surrounding and accompanying water was higher than the permissible limits (4774.45) and (2600) ds/m2, respectively, which recommended the standard of (2000) ds/m2 as one of the highest. While we find that the beaches of the city of Zwara were not affected by these high concentrations of conductivity, as they recorded (3500.8) ds/m^2

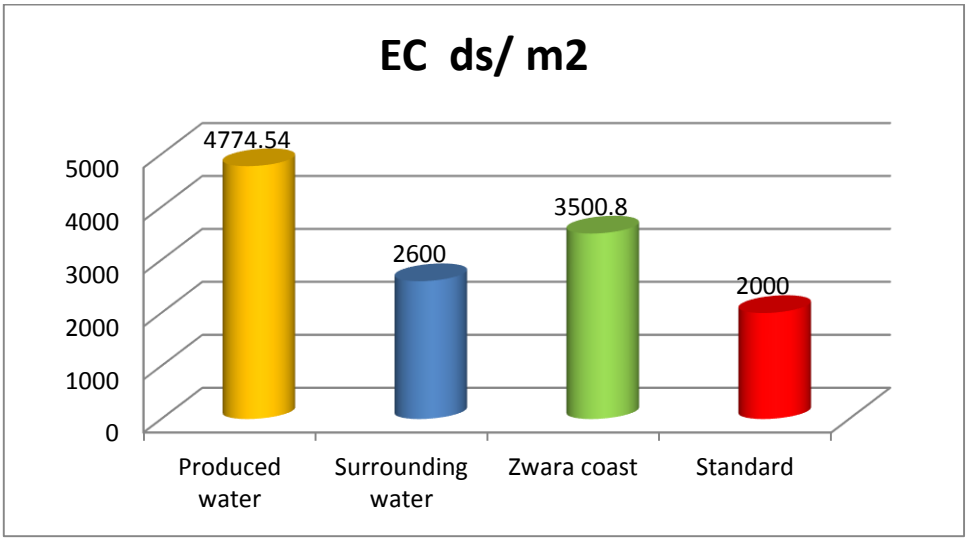

Figure No. (3) shows the conductivity concentration of the studied samples

Concentration of some radioactive materials in the studied samples

Bismuth

Bismuth is considered one of the least toxic elements compared to other heavy radioactive elements. Its accumulation rarely causes health problems that can lead to unknown effects on marine organisms, but it may cause harm if consumed in large quantities. bismuth elements was higher than the recommended threshold values in all the studied which recommended the standard of (0,02) Bq/L as one of the highest. While we find that the beaches of the city of Zwara were not affected by these high concentrations as shown in Figure No. (4)

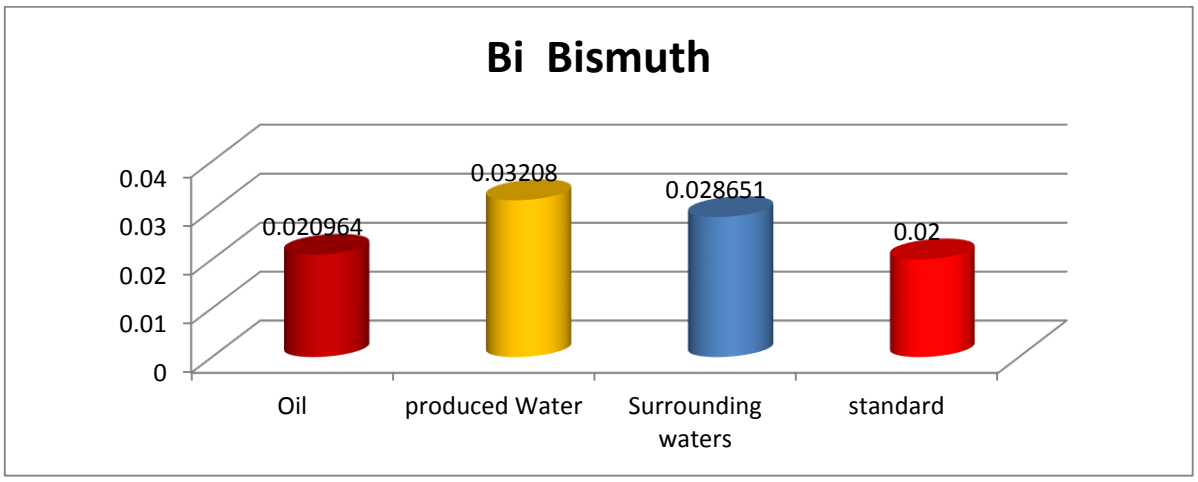

Figure (4) shows the concentration of the element Bismuth in the studied samples

Thallium

The radioactive element thallium is highly toxic to marine organisms and can cause death in fish and other organisms. Exposure to thallium can cause nervous system damage and other serious health problems. (Bleise *et al.*, 2003) The study, as shown in Figure No. (5), showed that the concentration rates of thallium were higher than the permissible limits in all the samples studied, which recommended a standard of 0.01 Bq/L, and its concentrations in the surrounding water and produced water were (0.03263), (0.04567) Bq/L. respectively

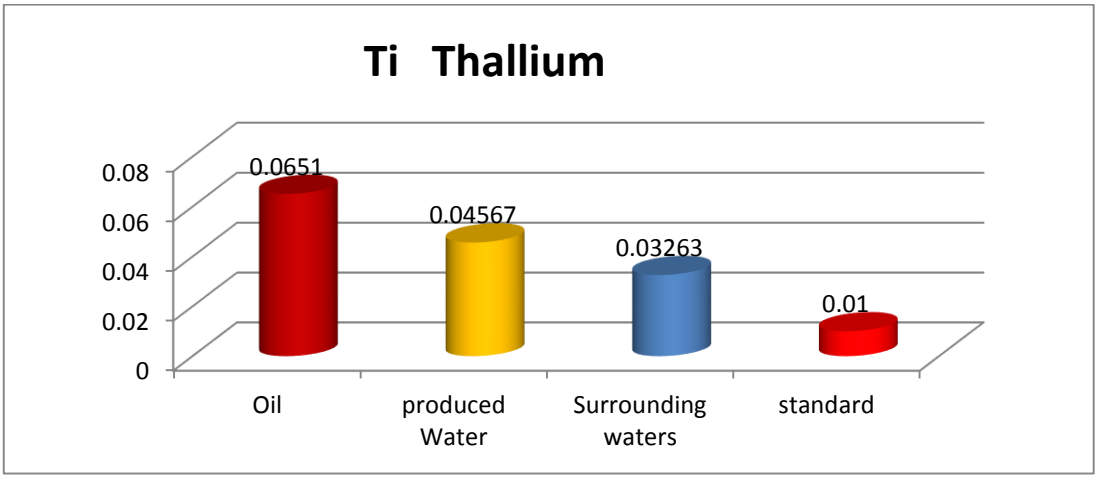

Figure (5) shows the concentration of the element Thallium in the studied samples

lead

Lead pollution harms marine ecosystems by affecting biodiversity. Exposure to lead causes poisoning, which negatively affects the nervous system and kidneys. (McCarthy & Smith, 2018) The study, as shown in Figure No. (6), showed that the

concentration of lead was higher than the permissible limits in all the samples studied, which set the standard at 0.03 Bq/L, while the accompanying water recorded a concentration of 0.0651 Bq/L.

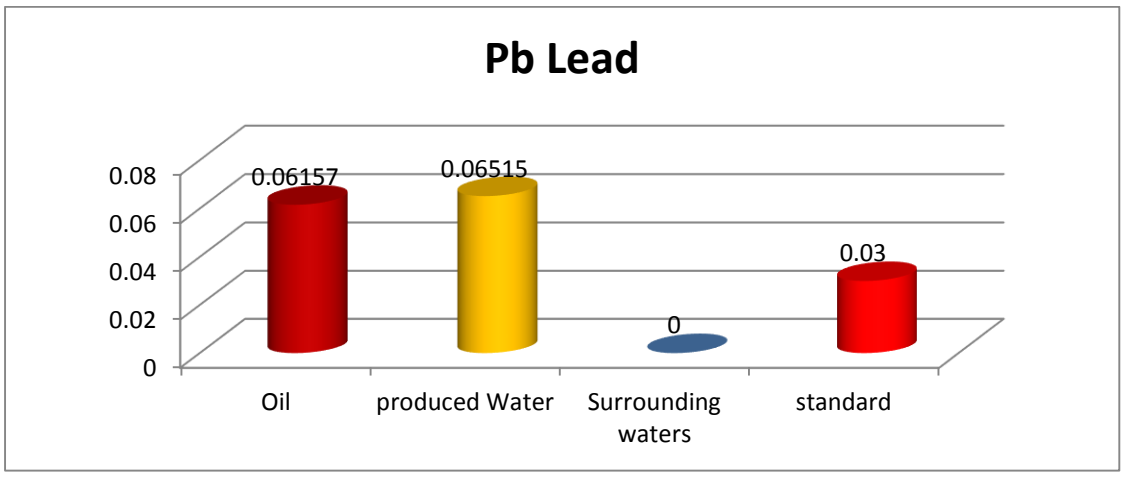

Figure (6) shows the concentration of the element Lead in the studied samples

Cadmium

Cadmium greatly affects marine life and causes toxic accumulations in marine organisms that affect the kidneys and respiratory system. (Agency for Toxic Substances and Disease Registry, 2007) The study did not record concentrations of cadmium in the surrounding water and in the crude oil sample, as shown in Figure No. (7). However, the concentrations of the element in the produced water were equal to the permissible standards, which set the standard as 0.02 Bq/L. The accompanying water recorded a concentration of 0.02 Bq/L

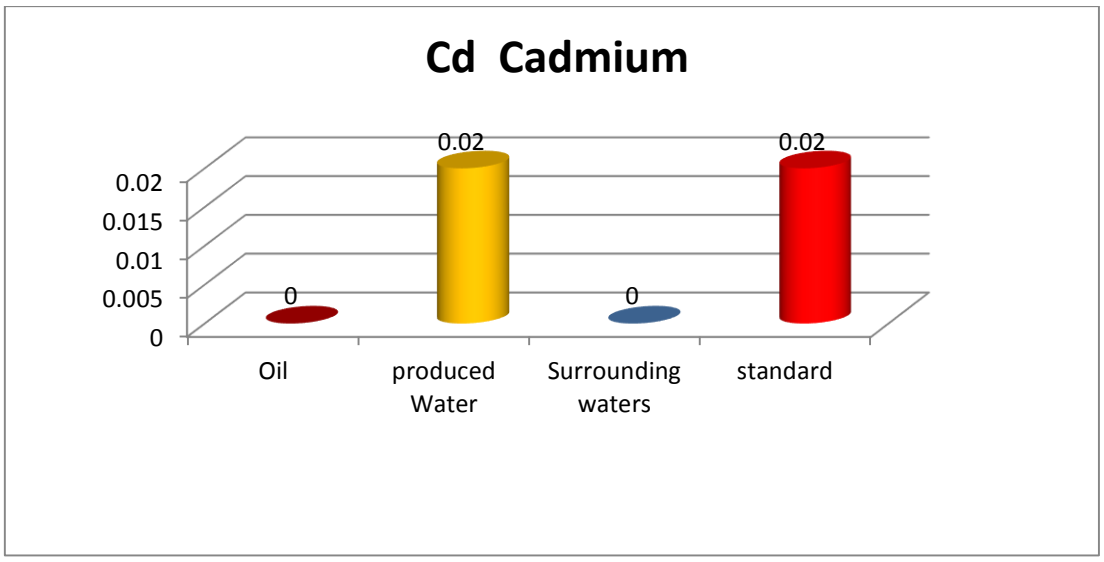

Figure (7) shows the concentration of the Cadmium element in the studied samples

palladium

The effect of palladium on the marine environment is not fully understood, but it can cause environmental poisoning. There is not enough information about the effect of palladium on human health, but it is likely toxic at high levels. The study did not record concentrations of the element palladium in the produced and ambient water. It showed the presence of fluctuating concentrations of the element in the crude oil sample (0.02096) Bq/L, which is much less than the permissible standards, which set the standard of 10 Bq/L, as shown in Figure No (8) .

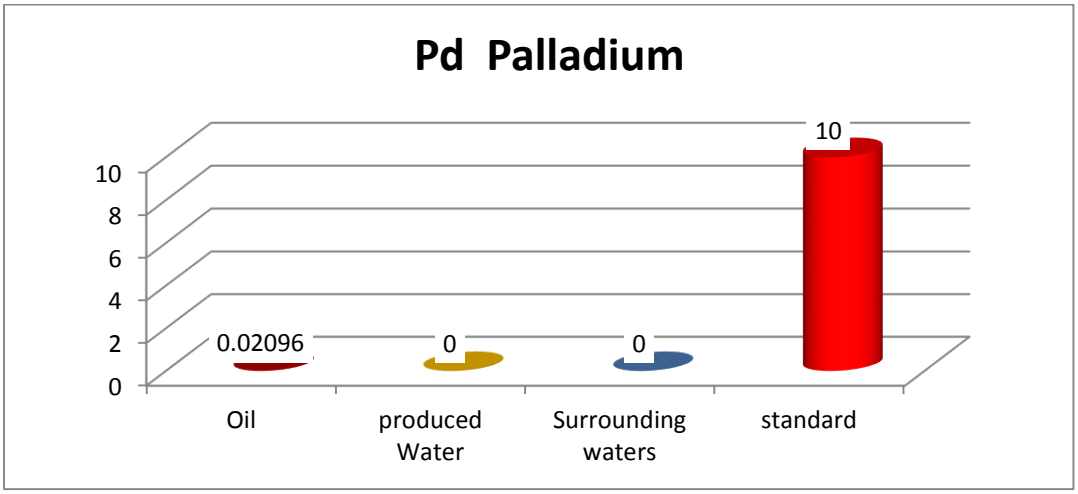

Figure (8) shows the concentration of the element Palladium in the studied samples

Potassium

Potassium is less dangerous, but high levels can affect the ion balance in the water. It is usually not toxic, but it can cause heart problems if its concentration is too high. The study did not record high concentrations of potassium in all the samples studied. They ranged between (0.2253) and (0.2501) Bq/L in the produced and surrounding water, which is much lower than the recommended standards (12) becquerel. as shown in Figure No. (9)

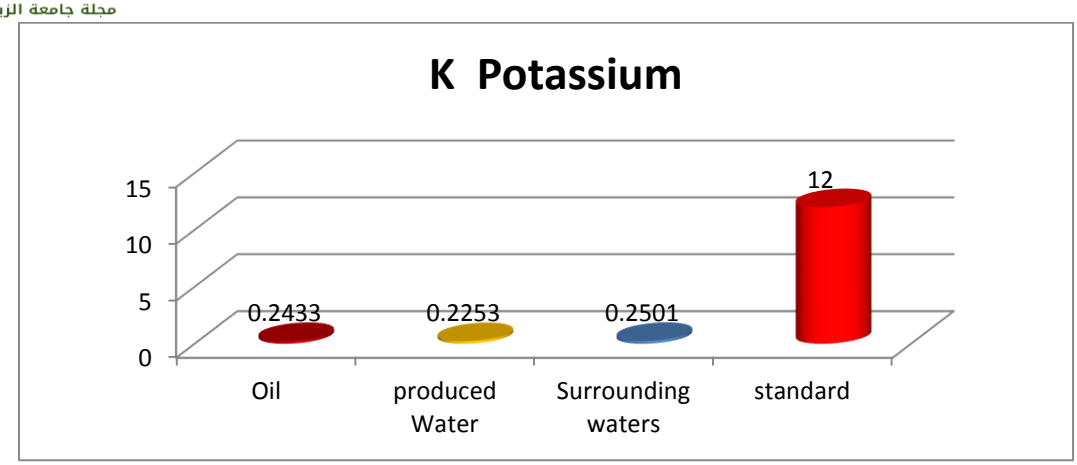

Figure (9) shows the concentration of the potassium element in the studied samples

Actinium

Actinium is a radioactive element that is rarely found in the marine environment, but can cause damage if released. It can be radioactive and toxic, and cause serious health problems if humans are exposed to it. The study recorded high concentrations of the element actinium in the surrounding water in the oil sample and the surrounding water. They were (0.036258) and (0.0331) Bq/L, respectively, which are much more expensive than the recommended standards (0.02) Bq/L, as shown in Figures No. (10).

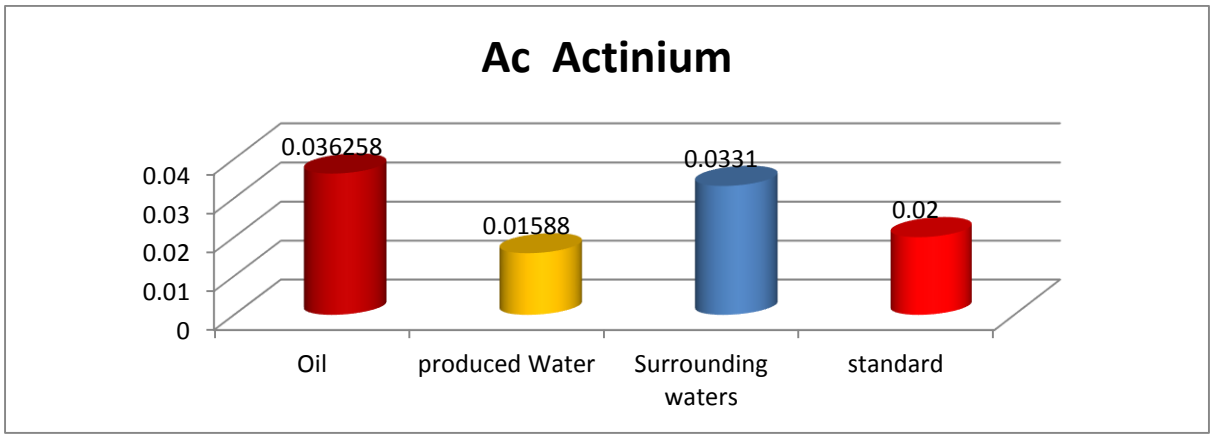

Figure (10) shows the concentration of the element Actinium in the studied samples

Tungsten

Tungsten is not highly toxic, but it can affect some marine organisms if present in high concentrations. Tungsten is generally not toxic to humans, but some of its compounds may be harmful. The study, as shown in Figure No. (11), showed high concentrations of the element tungsten in the surrounding water, exceeding the recommended standards (0.06059) Bq/L, which recommended the standard (0.02) Bq/L.

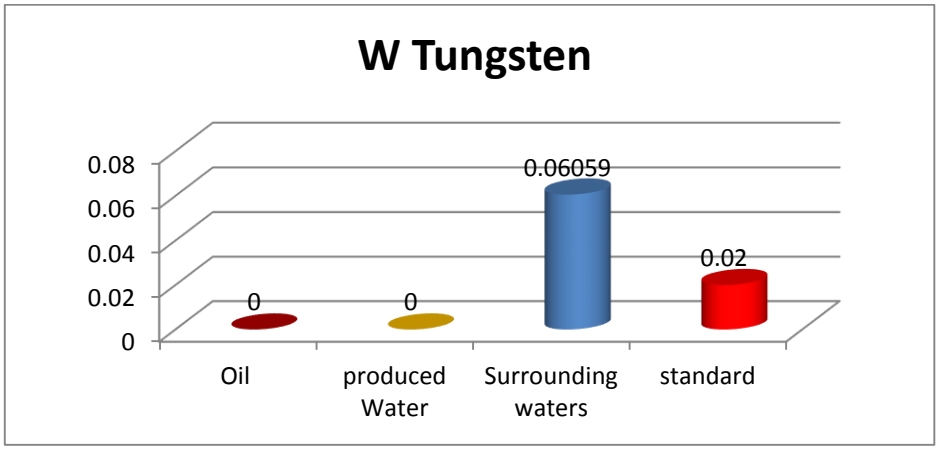

Figure (11) shows the concentration of the element Tungsten in the studied samples

Uranium

Uranium is a radioactive element and causes radioactive contamination in the marine environment, harming living organisms. Exposure to uranium is linked to the risk of cancer and other health problems. (Bleise *et al.*, 2003) The study recorded high concentrations of uranium in the produced water, which was (0.1948) Bq/L, which is much higher than the recommended standards (0.02) Bq/L, as shown in Figure No.(12 .)

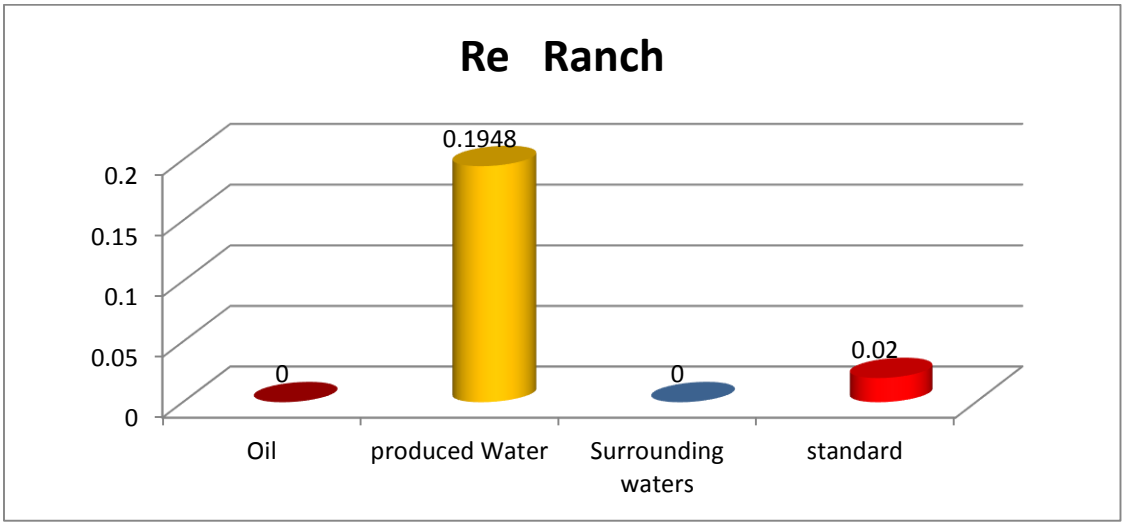

Figure (12) shows the concentration of the element Ranch in the studied sample

Statistical Analysis Report:

ANOVA and Tukey Test Results

Variable	ANOVA Value	Significance Level	Tukey Test	Interpretation
pH	0.892	Non-significant	Not applicable	Uniform pH levels across samples
Electrical Conductivity (EC)	0.034	Significant	Statistically significant	Clear differences between water samples
Potassium (K)	0.762	Non-significant	Not applicable	Consistent potassium concentration
Cadmium (Cd)	0.056	Marginally significant	Moderately significant	Limited variation in cadmium levels
Lead (Pb)	0.021	Significant	Statistically significant	Substantial differences in lead concentration
Thallium (Ti)	0.015	Significant	Statistically significant	High variation in thallium levels
Bismuth (Bi)	0.587	Non-significant	Not applicable	Homogeneous bismuth concentration
Actinium (Ac)	0.449	Non-significant	Not applicable	Consistent actinium levels
Uranium (Re)	0.072	Marginally significant	Limited significance	Weak variation

Conclusion

From these results it can be concluded that oil extraction, transport and refining have an important impact on the marine environment and the quality of coastal waters and that the accompanying water treatment operations carried out by ENI's Italian partner, the foreign partner of the National Oil Corporation, are useless, as there are already treatment processes for this water, which can be observed in the levels of Different types of pollutants, and this effect has been reflected in the increasing levels of heavy metals and petroleum hydrocarbons for the environment surrounding the Al-Bouri field platform and the beaches of the of Zwara. City
The statistical analysis reveals significant variations in electrical conductivity, lead, and thallium concentrations, warranting detailed environmental investigation and monitoring

Recommendations

1. Implementing the laws and legislation stipulated to protect the marine environment, by imposing complete control and criminalizing any entity or facility that prevents this from being achieved.
2. Educating citizens about the importance of preserving the integrity of the marine environment and its relationship to preserving marine wealth and the national economy, through preparing and presenting educational programs in particular through various media.
3. Supporting research studies concerned with protecting the marine environment from sources of pollution of various types in order to protect public health and bring the marine wealth sector to a level that can be relied upon as a pillar of the national economy.
4. Planning a network of unified and integrated environmental projects for scientific and technical research and establishing centers for training activities to provide specialists and technical cadres whose main interest is in protecting the marine environment from pollution and offering solutions to its problems.
5. Monitoring the disposal of waste in its various forms, including industrial, oil, nuclear, agricultural, domestic, and others, and adopting medium- and long-term scientific solutions that limit the spread of pollution.
6. Tightening supervision on foreign companies investing in the oil field, as well as oil carriers, in how to get rid of petroleum pollutants during production processes and disposal of ballast water in the coastal environment.
7. Conduct further environmental monitoring
8. Investigate sources of lead and thallium variations
9. Regular water quality assessment
10. Implement potential remediation strategies

Reverence

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