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Detection of contamination with the element uranium U92 in some soils in the Samawah Desert (AL-Muthanna Governorate)

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Abstract

The study was conducted on a part of the Samawah desert soil located in the southern part of AL-Muthanna Governorate, with the aim of studying the distribution status of contamination with uranium, focusing on its environmental and health impacts, and to analyze uranium concentrations in soil samples. It started reviews the methods of soil pollution in general, addressing how uranium enters the environment due to human activities such as mining and the use of depleted uranium, in addition to the geological factors that affect the concentration of uranium in the soil. Samples were

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collected from different locations in the region, and the results showed variations in uranium concentrations between samples. Uranium concentrations ranged between 0.00003% and 0.00279%, with some samples, such as the sample, exceedingS31 registered (27.9 ppm) parts per million), which far exceeds the expected natural limits for uranium concentrations in soil. And when comparing results with global environmental standards, such as those set by the World Health Organization (WHO) and the U.S. Environmental Protection Agency (EPA) found that many samples exceeded normal levels, indicating environmental contamination. In particular, samples containing elevated uranium concentrations are indicative of an unnatural source of contamination, such as industrial waste or military activities. That The potential environmental and health impacts of this contamination include contamination of groundwater and surface water, which can cause serious health problems such as kidney damage when contaminated water is consumed. Exposure to uranium in soil can also negatively impact plants and crops, potentially leading to reduced agricultural productivity.

Keywords: Uranium92, XRF, Contamination, Soil Minerals, Environment.

Introduction

Soil Pollution is the damage of the topmost layer of soil, where the valuable nutrients are favorite for the growth of plants, caused by the introduction of harmful substances in the soil thereby rendering it unfit for use as it is supposed to be fit to be used. Common pollutants are heavy metals and mineral compounds, pesticides, or organic substances resulting in different environmental problems. One of these contaminants, uranium 92 is particularly concerning because of its radioactivity and potential health hazards. This isotope can be found on soil as a result of mining activities, incorrect waste deposit, and industrial activities causing soil contamination and can lead to health risks for local human populations. (Corpus et al., 2023)

The environmental consequences of soil pollution could be serious, including the disturbance of plant and ecosystems and the pollution of water. Crop failure can result from having contaminated soil, which means it may be hard for farmers to safely grow crops. What's more, poison in tainted soil can seep into groundwater, threatening humans and wildlife.

The importance of soil pollution lies in the fact that it reflects the wider effects of our actions. Human being on the environment. In particular, the occurrence of uranium-92 in soil underlines the importance of investigating its sources and pathways to the ecosystems. This direction naturally leads us to investigate the sources of uranium pollution and the pathways by which it influences the quality of soil, highlighting the necessity to take this type of environmental problem seriously.

Uranium contamination originates primarily from natural and human sources, significantly impacting soil quality. Uranium occurs naturally in various geological formations and can Erosion leads to release it into the environment. This process can lead to a gradual accumulation of uranium in the soil, especially in areas with high mineral content. However, the impact of human sources, particularly mining and industrial activities, being More clear. (Duhan et al., 2023)

This Study Aimed to Achieve the Following Objectives:

1. Determination of uranium concentration in some of AL-Muthanna Governorate soils using accurate measurement techniques.
2. Analyze the impact of environmental and human factors that may contribute to increased levels of radioactive contamination.

The Concept of Rare Earth Elements:

Over the past years, rare earth elements have played an increasingly important role in modern technologies, as they are used as a basic raw material in the manufacture of many things, ranging from smartphones to disk drives, wind turbines, satellites, superconductors, electric car components, and other modern industries. Despite Although they are called rare elements, they are more abundant on Earth's surface than many other valuable elements. For example, thulium, with atomic number69, approximately 125 times more common than gold, which is one of the rarest rare earth elements on Earth. Cerium, with atomic number 56, is one of the most abundant rare earth elements, 15,000 times more abundant than gold. While some consider them rare, mineralogists call them "dispersed," meaning they are often scattered across the planet in relatively low concentrations. Rare earth elements are often found in rare volcanic rocks called carbonates, the most famous of which are basalt in Hawaii or Iceland, andesite in Mount St. Helens or Volcano Fuego in Guatemala (Merzman, 2018).

The term elements refer to Rare earth minerals (REEs) REEs, as defined by the International Union of Pure and Applied Chemistry, are rare earth metals that form a group of 17 very important chemical elements of the periodic table, specifically scandium, yttrium, and the lanthanides.

These elements were called "rare" because of the scarcity of places from which they were extracted, but recently a relatively high concentration of these elements - with the exception of the unstable promethium - has been found in the Earth's crust, with cerium being the element of the order25 of the most abundant elements in the Earth's crust, with a concentration of 68 parts per million (Anenburg et al., 2020).

One such earth element is uranium 92 whose naturally occurring isotope, uranium, is present in soils across the globe in trace amounts. It is largely associated with geological phenomena, being emitted into the atmosphere via the weathering of rocks and minerals containing uranium. This mechanism eventually leads to higher background uranium levels in a wide range of soil types. Unfortunately, humans have severely contaminated the soil with such activities as farming and the utilization of DU (Depleted Uranium) for military purposes. These sources of anthropogenic uranium can raise uranium levels in certain places, with potential risks to the environment and the health of those affected. (Hasaan et al., 2023)

Uranium U 92 concentration in the soil surface varies over a range of 10 to 1000 Bq/kg concentration in soil is a complex function of a variety of geological factors such as mineral composition of the soil and local geological history. Granitic rocks, phosphatic rocks and the like, are rich in minerals, and hence these areas of natural uranium are highly abundant in uranium. There is also a significant role for environmental geology in the dispersion the uranium in soil. The mobility and bioavailability of uranium can be controlled by parameters as soil pH and moisture, and by the presence of organic matter, leading to differences in the contaminated levels between ecosystems. Increased concerns over uranium contamination have led researchers and regulators to investigate uranium limits in soil. The monitoring work has evolved to a point where it is necessary to detect uranium by techniques such as X-ray fluorescence for meaningful contamination determinations. It is important to establish these limits in order to assure protection of the environment and public health from the detrimental effects of uranium exposure. This information on both natural and anthropogenic uranium in soil will help guide the debate and discussion on regulations set for uranium concentration, the next important parameter to be considered when considering the risk impacts of uranium contaminated soil.

Limits and Concentration of Uranium in Soil (U92):

Uranium determinations in the soil is an essential matter for environmental and possible health concerns. Soil sampling methods are highly diverse and results may differ considerably. For instance, sampling soil at various depths and points give the researcher a better understanding of where uranium is and is not.(Horvath et al., 2022)

Uranium content is quantified using different methods such as gamma spectrometry and XRF. These techniques make it possible to determine and measure uranium isotopes in samples of soil. But the detection method can influence the measured uranium concentration, gather not all isotopes with all methods could be detected. As researchers continue this work, improvements in methods for detection of uranium are enhancing confidence in the measurements made for the monitoring of uranium, enabling a clearer picture of sources of contamination and risk to health.

Many environmental groups establish soil maximum allowable levels for uranium based on science and health. These limits can be employed to reduce uncertainty in risk assessments with respect to natural and anthropogenic uranium sources. Dependence of mobility of uranium on anionic species form has impactions for local population living close to mine or industrial area however due attention for monitoring and assessment of the same is needed.

Successful management of uranium in soil is important to protect human health and safety and allows the land to be utilized for agriculture, recreation and habitation. It is informative to know what the threshold limits are to guide mitigation and restoration efforts. It is important to reflect how such limits on uranium in soil have been interpreted and implemented when being scrutinized for the uranium content in soil. It is important to determine site-specific concentrations of uranium in various environments to best assess the risks and actions necessary for the protection of human health and the environment. (Dietl et al., 2023)

Health Risks Associated with Uranium 92:

Health risks of uranium 92 likelihood of exposure determinant thin and decay prod radiation poisoning radiation toxic (no risky - Ur (a)-nuclear weapons facilities as a consequence of '''radiological toxicity''' (alpha particles) and (heavy metal) chemical toxicity. If uranium is found in the environment, mainly in areas of elevated levels, people can be exposed to it by breathing dust, drinking water and eating food that

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contains uranium, and touching the skin. Such exposure can result in a number of health consequences mostly attributed to the element's radioactivity and heavy metal toxic properties.

Static feel Anxious from uranium 92 radiation exposure Let's use our heads is worried about it. When in haled or ingested, alpha particles emitted by decaying uranium isotopes can damage internal organs. This form of radiation is concerning because it can harm living tissue and potentially increase the risk of cancer. Prolonged exposure to low levels of EPA is linked to an elevated risk of a number of different types of cancer, particularly lung and kidney cancer. (Schmitz-Feuerhake et al., 2016).

Apart from its radioactive hazards, uranium is a heavy metal, which can be harmful to the human body. Uranium can produce toxicity in the kidneys, since the kidneys filter and eliminate heavy metals. Over the years, it can cause chronic kidney disease, among other serious health problems. Studies have demonstrated that populations living close to uranium mines or contaminated sites suffer from health effects more frequently than residents from non-exposed areas.

The characterization of these health outcomes is crucial for developing effective intervention and treatment approaches. By understanding the risks of uranium exposure, in particular to contaminated areas, proactive measures to minimize exposure can be taken to ensure public safety. (Zhang et al., 2022)

For uranium 92 High environmental effects due particularly in high concentration regions. Most importantly soil degradation is the most significant when materials from uranium work become deposited, and flow accumulates on its surface and the natural properties of this land has disturbed. (Ma et al., 2019)

By appreciating these consequences, the immediate necessity of addressing uranium contamination in the environment is also increasingly apparent. The impact of uranium mining on soil and water increases significantly when those uranium mining operations are expanded. Such a link opens up discussions on the role of uranium mining practices in the local soil contamination and underlines that responsible supervision and management of such practices are crucial in order to safeguard both environmental and human health.

Detection Methods and Uranium 92 Processing:

Soil uranium 92 detection is necessary for assessing the environmental effect and potential health hazard. A number of detection techniques are employed but the principal ones are XRF and gamma spectroscopy. XRF is a non-invasive method which detects uranium-containing samples through the quantification of characteristic X-rays produced following the irradiation of a sample with an X-ray source. This approach permits a quick way to analyze and obtain the uranium concentration data in soil samples, which avoids undergoing a very long process of sample preparation.

Gamma spectrometry, on the other hand, is based on the measurement of the radiation of gamma rays from radioactive isotopes such as uranium. 92. This technique is based on the analysis of gamma-ray energy spectrum and identifies not only uranium, but also its decay radioactive progeny. The benefit of gamma spectrometry is that it can measure uranium levels even if they are low, and it is especially applicable in areas previously mined or where other sources of contamination exist.

Appropriate soil sampling methods are also critical in producing samples representative of the subsurface for these detection techniques. It also allows for sampling of depths and locations that can capture variability in uranium concentration from geological and human sources. When paired with good sampling techniques and advanced detection technologies such as x-ray spectroscopy (XRF) and gamma rays, researchers are better equipped to understand the distribution of uranium in the environment.

Knowing how to detect uranium92 what to measure knowing how to detect it is a vital step to managing the risks associated with uranium's presence. These risks can extend from (but often move far) from environmental effects to public health impacts, especially as it applies to the potential of cancer in connection to uranium exposure. As we investigate the health risks, it is evident that efficient detection processes cannot be for monitoring purposes alone, but are also important to safeguard communities against the risks associated with uranium in soil.

Nuclear processing methods as uranium up to 92 to de-contaminate the soil by removing harmful elements. For this purpose, many approaches are adopted, of which phytoremediation appears as an eco-friendly one. This method depends on plants that take up uranium from the soil, or bind it in some way through their roots. There are some really great plants for this, and they work, in part, because they are capable of withstanding and storing heavy metals, uranium included. As these plants mature, they work to clean the soil over time, rendering it safer for both the surrounding environment and future agricultural use. (Alori & Fawole, 2017)

Another successful approach is chemical stabilization, in which certain soil additives combine with uranium to keep it from spreading. This practice decreases the bioavailability of uranium which otherwise can leach into groundwater and/or be taken up by plants. Typical stabilizing agents are phosphate or lime as those react with uranium to less soluble species. It is very helpful in places where it is hard for the plant to grow right away. Soil washing is also a physical removal technology. This involves the use of water and chemicals to leach uranium particles from the soil. This water is then treated to clean the uranium from it, then released or, where possible, recycled. For some sites with high and small-scale uranium levels, soil washing is potentially very effective. Although such remediation can result in large reductions in total uranium concentrations in soils contaminated with this substance, success sometimes depends upon risk perceptions and understanding by affected communities with respect to uranium contamination and risk.

Although such remediation can result in large reductions in total uranium concentrations in soils contaminated with this substance, success sometimes depends upon risk perceptions and understanding by affected communities with respect to uranium contamination and risk. Raising awareness among affected communities about the possible dangers of uranium exposure can help to increase community support of and participation in remediation and monitoring and cleanup. Public dialogues on soil health and safety can help the public make more informed decisions and work together to create healthier surroundings.

Advances in detection technologies are the reason behind the revolutionary changes that are taking place now in environmental monitoring, where uranium can be determined. 92 in soil. New methods are being developed to provide increased accuracy and efficiency in identifying those uranium levels that present a hazard to human health and the environment. For instance, a portable spectrometer, as well as state-of-the-art XRF equipment, can be used for on-site real-time testing, thus avoiding cumbersome laboratory analysis. With these instruments, uranium levels may be determined in real time, contributing to a more rapid remediation. (Neri, 2015).

Future Research Directions on Uranium:

Possible future research areas on uranium 92 in soil were thought to include occurrence of "emerging contaminants" in soil and new technology for remediation. One interesting direction is the relationship between uranium-92 and other pollutants that can be found in mining, prospective industrial areas and agricultural land. Investigating how these pollutants work together can uncover surprising risks and support the development of all-inclusive plans for handling them. (Queen et al., 2024)

Prospective cohort studies are necessary to evaluate chronic effects of uranium exposure. 92 on soil health and the health of surrounding ecosystems. Researchers can track soil health over time and learn how the concentration of uranium changes, as well as the conditions that worsen or rid contamination. They also contribute to determining safe levels of uranium in soil for maintaining sustainable agriculture without compromising public health.

Promising remediation solutions available for uranium contamination should be further explored with the aim of mitigating the deleterious effects. It may be that researchers could explore the potential of so-called advanced bioremediation techniques, which involve exploiting microorganisms or plants to remove or stabilize uranium from the soil. This strategy, in addition to lowering uranium levels, seeks to improve soil health through biodiversity enhancements. In addition, the new detection technologies, such as X-ray florescence, are to be incorporated into the monitoring scheme. These resources make it possible to obtain instantaneous results in uranium concentrations in soil, allowing for the immediate to contamination accidents and risk assessment.

Materials and Working Methods

Preliminary Procedures:

In order to implement the objectives of this study we used some of the available aids for the region, including some geological maps, in addition to some previous studies. For the region. The identification process has been completed. Sampling place soil In fact 9 sample At each study site.

Table (1): Coordinates to the study area sites

Sample	long	lat
S11	45,026	31.3020
S12	45.0298	31.3057
S13	45.0163	31.3096
S14	45.0189	31.3128
S15	45.0089	31.3248
S16	45.0125	31.3273
S17	44.9979	31.3339
S18	45,002	31.3400
S19	45,022	31,323
S21	45,048	31,309
S22	45,058	31,300
S23	45,039	31,293
S24	45,049	31,286
S25	45,027	31,287

Sample	Long	lat
S26	45,038	31,276
S27	45,006	31,285
S28	45,017	31,268
S29	45,011	31,254
S31	45,043	31,253
S32	45,052	31,264
S33	45,069	31,281
S34	45,094	31,285
S35	45,116	31,294
S36	45.102	31,255
S37	45,129	31,267
S38	45,043	31,253
S39	45,052	31,264

Field Procedures:

Included the field workers made several reconnaissance trips to identify sampling sites, and as a result, and 27 Soil samples were collected using 1 kg bags and all sampling sites were identified using a device. GPS type (Garmin) (Garmin GPS map 60 CSX) as shown in the coordinate table number (3) Samples and satellite image form number (1).

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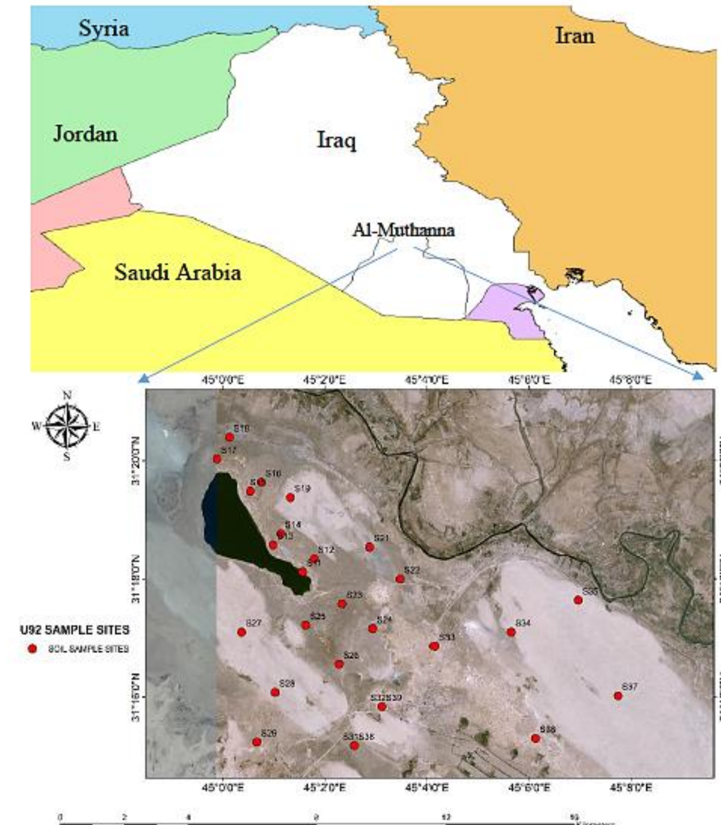

Figure (1): shows a map of the researchers' work on this study

Laboratory Procedures:

Firstly: Preparing Samples for Laboratory Analysis

The soil sampling process was subjected Toto Several points are:

1. **Randomization:** Soil samples were collected randomly to give a true representation of the specific site.
2. **Location:** That Site selection is an important process and is one of the key points through which data is provided that enhances the concentration of elements for the selected area.

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3. **Size:** Sample size to be studied the texture of the soil in it 1-2 kg approximately of each Site of Sites studied for potential damage Storage bag An error occurred In experiment or other Reasons.
4. **Labeling & Date:** The process of marking and dating the bags containing the soil sample was very important so that the samples taken from different areas would not get mixed up in different times.
5. **Preserving:** Samples were kept at take it from the sites and transferred to the lab to start work or Until Examination on it.

Figure (2): shows the study soil samples

Secondly: Chemical Estimates:

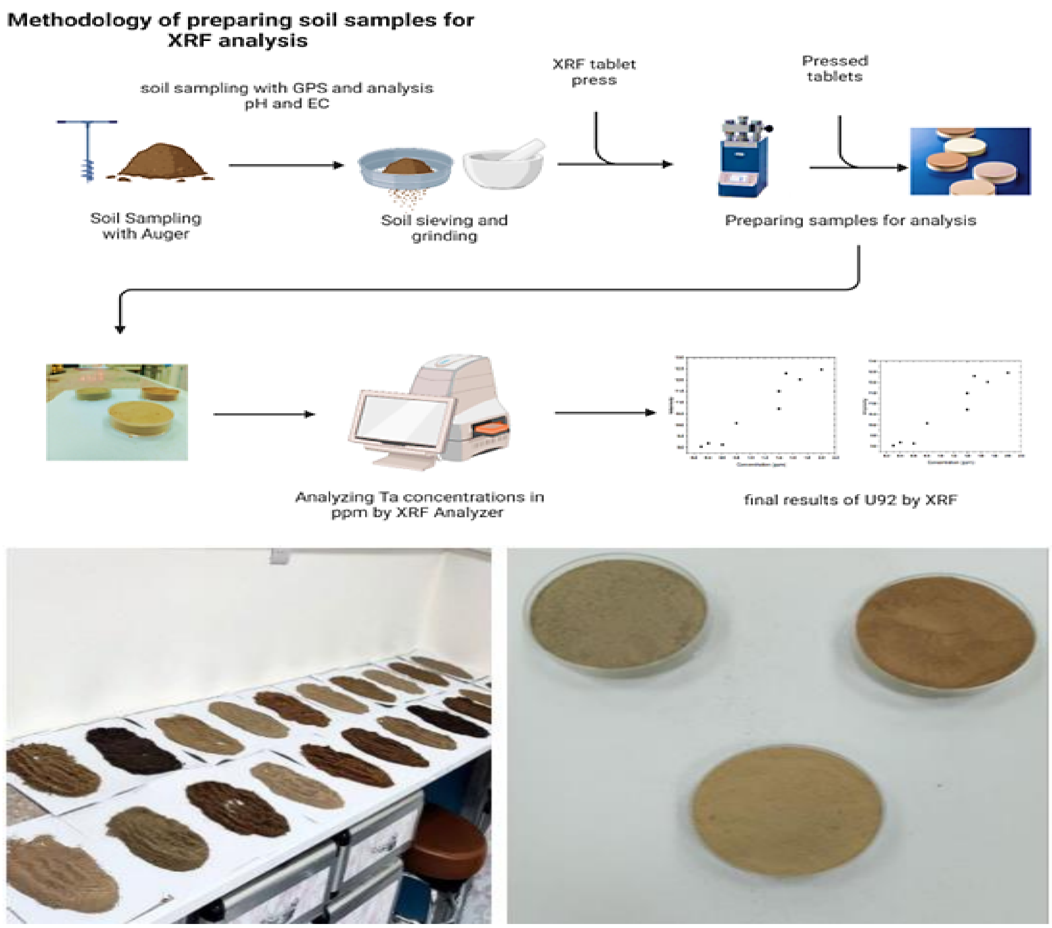


Figure (3): Preparing soil samples for compaction (Methodology)

Uranium U92 Element Estimation:

Device used XRF (X-Ray Fluorescence) in estimation of the element uranium.

1. The samples were sieved and ground into a very fine powder. About 2 microns.
2. Packaged in tablet-shaped containers small where it is placed inside the device XRF.
3. It was appreciated Percentage of component Uranium in each soil sample and then determine the concentrations Element with ppm.

Results and Discussion

Uranium Element in Soil U92:

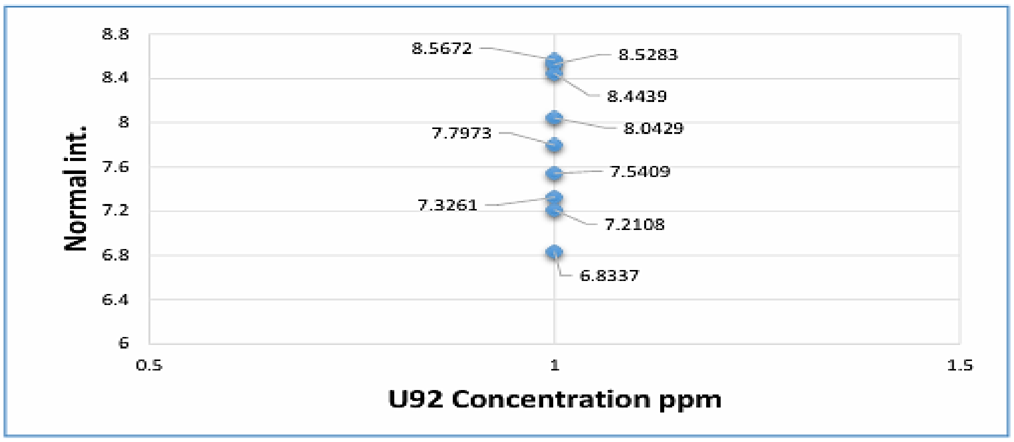
Soil samples were analyzed. In the study area to assess the extent of environmental contamination with uraniumU92. The results showed that some samples contained uranium concentrations exceeding 1.0 parts per million (ppm) and reaching approximately 27.9 ppm. Natural levels of uranium in soil were determined globally, and reference values or maximum permissible limits were compared according to international environmental standards (such as the US Environmental Protection Agency (EPA) and the World Health Organization (WHO). In addition, the results assessed whether the measured concentrations indicated serious environmental contamination and identified the potential environmental and health impacts of elevated uranium levels in soil.

Table (2): Chemical properties of the studied soil samples

site	y	x	concentration %	concentration ppm	Normal int.
S11	45.026	31.302	0.00010%	1	7.7973
S12	45.0298	31.3057	0.00010%	1	7.5409
S13	45.0163	31.3096	0.00004%	0.4	9.1787
S14	45.0189	31.3128	0.00054%	5.4	18.642
S15	45.0089	31.3248	0.00003%	0.3	9.029
S16	45.0125	31.3273	0.00075%	7.5	25.1798
S17	44.9979	31.3339	0.00010%	1	8.4439
S18	45.002	31.34	0.00112%	11.2	29.8651
S19	45.022	31.323	0.00010%	1	6.8337
S21	45.048	31.309	0.00014%	1.4	10.7258
S22	45.058	31.3	0.00042%	4.2	16.1459
S23	45.039	31.293	0.00008%	0.8	10.0818
S24	45.049	31.286	0.00014%	1.4	11.495
S25	45.027	31.287	0.00015%	1.5	12.2985
S26	45.038	31.276	0.00109%	10.9	29.7179
S27	45.006	31.285	0.00197%	19.7	45.7114
S28	45.017	31.268	0.00222%	22.2	52.0378
S29	45.011	31.254	0.00173%	17.3	40.4801
S31	45.043	31.253	0.00279%	27.9	59.2343
S32	45.052	31.264	0.00020%	2	12.4659
S33	45.069	31.281	0.00010%	1	7.3261
S34	45.094	31.285	0.00010%	1	8.5283
S35	45.116	31.294	0.00010%	1	8.0429
S36	45.102	31.255	0.00017%	1.7	12.0227
S37	45.129	31.267	0.00006%	0.6	9.1214
S38	45.043	31.253	0.00010%	1	8.5672
S39	45.052	31.264	0.00010%	1	7.2108

Compare the Results Measured with Reference Values:

The results showed that uranium concentrations ranged from more than 1.0 ppm for some samples, reaching about 27.9 ppm. In sample S31, these results clearly exceed natural soil uranium averages for most regions of the world. Even the minimum measurement 1ppm is close to the global average soil level, and the highest concentration (27.9 ppm) is about two to three times higher than the common upper limit of the normal range of about 10 ppm. (UNSCEAR, 2017).



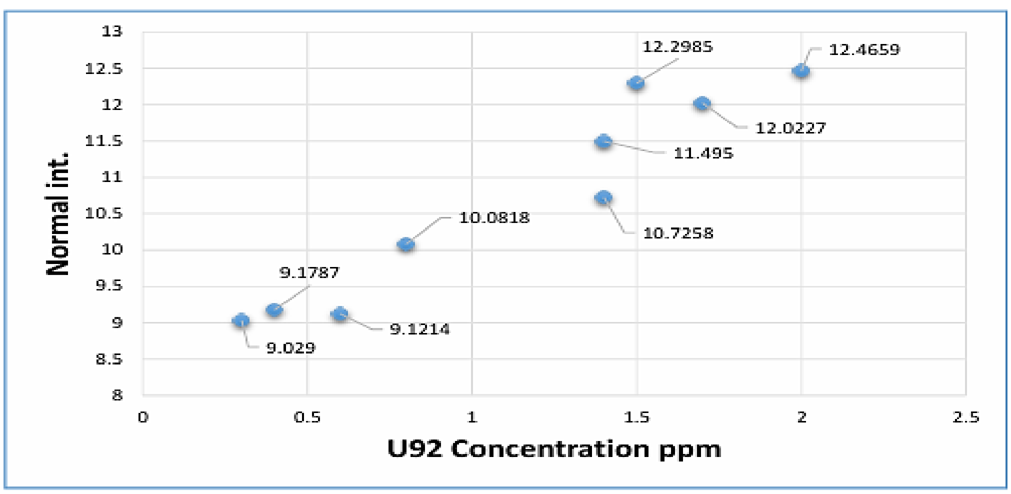


Figure (4), (5): U92 Concentrations 1, 2

It is likely that the high concentrations detected, especially those close to 28 ppm it indicates the presence of an unnatural source of uranium in the soil (environmental contamination). This may be the result of human activity such as the use of depleted uranium munitions in nearby areas, deposits from industrial and mining waste, or even long-term accumulation resulting from the use of phosphate fertilizers containing traces of uranium. Although the value is 28 ppm It does not reach the levels of highly contaminated sites (such as mine sites or uranium tailings where it may reach hundreds of ppm However, they are certainly higher than expected in natural soils and require additional attention and analysis to determine their extent and source. These concentrations represent significant environmental contamination that could have health and environmental consequences if not managed appropriately.

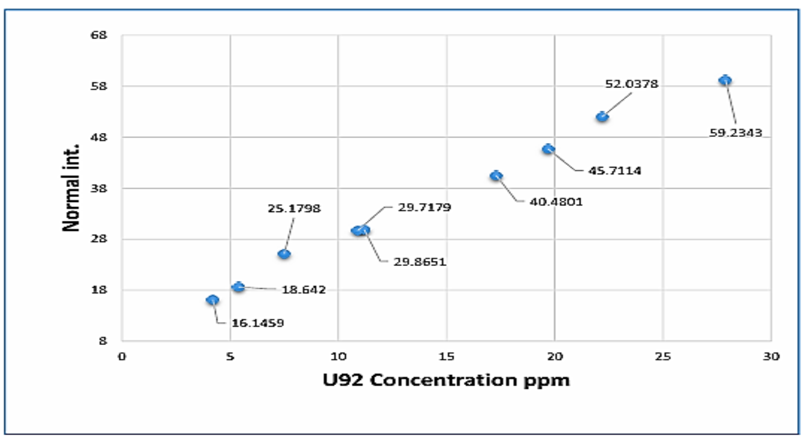


Figure (6): U92 Concentrations3

Potential Environmental and Health Effects of Elevated Uranium Levels:

Groundwater and Surface Water Pollution:

Uranium in soil can dissolve or be released with rainwater or irrigation, causing it to migrate to groundwater or surface water. Over time, uranium levels may rise in nearby well or spring water. This poses a health risk because drinking water containing high amounts of uranium can cause damage, primarily to the kidneys.

Global Health Organization WHO, 2011 set a drinking water limit of 30µg/L to protect the kidneys from the chemical toxicity of uranium. If uranium from contaminated soil leaks into drinking water and exceeds this limit, it poses a definite health risk.

Impact on Plants and Crops:

Plants can absorb small amounts of uranium through their roots from the soil. Generally, uranium is not considered a highly translocated element in the food chain compared to other heavy metals, and it does not accumulate in plant tissues at significant levels. However, in cases of industrial contamination, the uranium content of some crops or feed may be elevated. Studies indicate that even with the use of phosphate fertilizers containing traces of uranium for decades, no significant increase in uranium concentration in crops was observed compared to unfertilized soil. And some The other estimated the concentration to be around 5ppm in soil may cause negative effects on the growth of some sensitive plants.

Hence, having 28 ppm it may cause an effect on plants or soil, especially in the long term or under certain environmental conditions, such as acidic soil that may increase the mobility of uranium.

Radon Gas Emission:

Uranium is a naturally occurring radioactive element that emits alpha radiation at a very low rate, and its decay products, such as radon gas, are Rn-222One of the main sources of concern is radon. Radon can be released from the soil into the air and poses a danger indoors. The danger is that radon is a colorless, odorless gas that can leak into and collect in enclosed spaces (such as homes and buildings). Global Health Organization WHO, 2011 Radon is ranked as the leading cause of lung cancer after smoking. Radon levels in buildings depend on several factors, including the uranium content in the soil beneath the building. Therefore, higher levels of uranium in the soil may be associated with higher levels of radon emission, which calls for measuring radon levels in affected areas to protect residents from the long-term risk of lung cancer.

Direct Human Exposure to Contaminated Soil:

If surface soil is contaminated with uranium, humans may be exposed directly through skin contact, inhalation of dust, or ingestion of soil particles, especially children who may put contaminated hands in their mouths. Although uranium is a radioactive heavy metal, its most dangerous aspect is its chemical toxicity, not its radiation. The main health effect is related to kidney toxicity at high concentrations. that Chronic exposure to high levels of uranium may cause kidney damage (the organ most affected by uranium), affect liver function, or increase the likelihood of bone problems.

So, Studies have shown that long-term exposure to uranium may cause increased rates of some types of cancer, but this is often in the context of very high levels of exposure. (CCME, 2007).

And in case of concentration 28 ppm in soil, the direct health risk to the public occurs through dust or waterborne contamination from contaminated soil. If dust is controlled and uranium is prevented from seeping into groundwater, the health impact remains limited, but it remains higher than in uncontaminated soil and requires monitoring.

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