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BIOMONITORS FOR THE DISCOVERY OF U AND TH IN G. QATTAR AREA, NORTH EASTERN DESERT, EGYPT.

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ABSTRACT

Some plants in a particular locality containing radioactive materials can be used as a guide for the discovery of uranium, thorium, radium and other trace elements and they can indicate pollution in other localities.

Gebel Qattar is one of the most important localities from the radioactive point of view. Plants in Gebel Qattar are condensed in the course of rainwater that is coming from top of mountain. In the present study, five types of plants are recognized such as: Zilla spinosa, Zygophyllum coccineum, Fagonia boveana, Aerva javanica and Moringa peregrina. These plants are collected from four studied sectors: Qattar I (QI), Qattar II (QII), Qattar V (QV) and Wadi El Abde.

From the distribution of U and Th in the soil samples of the four localities studied, it was found that QI, QII and QV contain the highest concentrations of U relative to Wadi El Abde. Among the plant samples, it was found that Fagonia boveana, Aerva javanica and Moringa peregrina plants have the highest ability to absorb and concentrate the radioactive elements U and Th and two trace elements Mo and Pb. Thus, these plants are significant for exploration of radioactive elements in the studied area and can be used as biomonitors for the discovery of the radioactive and trace elements U, Th, Mo and Pb in other locations if they are available.

INTRODUCTION

The Eastern Desert of Egypt is considered as one of the hottest arid regions in the world. It lies nearly between latitudes 22° 00' and 31° 00' N, and longitudes 32° 00' and 36°00' E.

Gebel Qattar area, being a part of the Eastern Desert of Egypt, has a desertic type of climate. It is arid and hot in summer, mild to cold in winter. Temperature is high and ranges between 14° - 21.7°C in winter and 23° - 46.1°C in summer. The rainfall is occasional and scarce. The main bulk of rain occurs in winter. Summer is in general rainless. Surficial water resources are formed mainly of rain accumulation. It is coming from tops towards valley floors. Wind is occasionally strong during the winter season. The sky is clear through the whole year.

In general, the roots of the desert plants are of pointed shape and are adopted to change their directions on descending to depth and passing along the spaces between fragments of rock debris on research for water. Thus, their pass appears to be zigzag in shape and resembles snake's route to some extent. Its subsurface end is usually pointed downwards. The uranium concentration varies from 0.023 to 0.430 ppm in soil samples and from 0.026 to 0.216 ppm in plant samples (Azam and Prasad 1989). Steubing *et al.* (1993) found that the uranium concentration ranged from 5-1500 mµg/kg in soil and reached a maximum of 1860 mµg/kg in soil water. The adsorption of contaminated water is the main source of uranium accumulation in the different plant organs. He also found that plants are not only useful as

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indicators for the location of mineralization but also as bio-indicators for migration pathway of uranium contained by soil water. Dunn (1988) found that uranium concentration of several tree species decreased in the following order: Twigs > Leaves > Roots > stems.

The aim of this study is the evaluation of uranium and thorium accumulated in the soil by using the different natural plant species, growing in the studied area. These plants are used as indicators for search for the occurrence and accumulation of the radioactive minerals.

General Features

Gebel Qattar area is located in the north Eastern Desert of Egypt, between longitudes 33° 14' 11'' and 33° 20' 16'' E, and Latitudes 27° 04' 00'' and 27° 08' 30'' N, (Fig.1).

The mapped area is of rugged topography and is traversed by few major Wadis. The main Wadis dissecting the area have two major directions. The first is ENE-WSW to NE-SW and the second direction is NNW-SSE to NW-SE (Fig.2). The drainage system is very complicated and the area is dissected by many small Wadis and watersheds, which ultimately drain into the above mentioned two major Wadi trends.

The floor of the Wadis and their tributaries of Gebel Qattar area is generally covered by thick recent Wadi sediments. These sediments are unconsolidated, loose and consist of fluvial sediments formed of sands, pebbles, gravels, cobbles and boulders. Fluvial soils exist largely because of soil creep in areas of high relief. They are widespread allover the area filling the channels of the Wadis and their tributaries. Most of the gravel size of Wadi sediments can easily be identified in hand specimens, e.g. granitic, dioritic and volcanic gravels.

The Geology of Gebel Qattar area has been dealt with by many authors. Among these are Shalaby (1988, 1990, 1995 and 1996), Salman *et al.* (1990 and 1994), Roz (1994), Abu Zeid (1995), Moharem (1997) and Shalaby and Moharem (2001). In accordance with their data, they divided Gebel Qattar into many sectors according to the concentration of radioactive minerals; three of them (QI, QII and QV) are characterized by the highest concentration of radioactive minerals. The fourth sector (Wadi El Abde) is free from any radioactive minerals.

Gebel Qattar area is a part of the Arabian-Nubian shield and formed mainly of Precambrian basement rocks. The Precambrian rocks cropping out in the area include, younger granites, acidic dykes, Hammamat sediments, Dokhan volcanics and older granitoids (Oldest).

Structurally, the area is dissected by various faults mainly trending ENE-WSW, NNW-SSE, N-S, NW-SE and NNE-SSW (El-Rakaiby and Shalaby, 1988), (Shalaby, 1988, 1990 and 1995), (Roz, 1994) and (Abu Zeid, 1995).

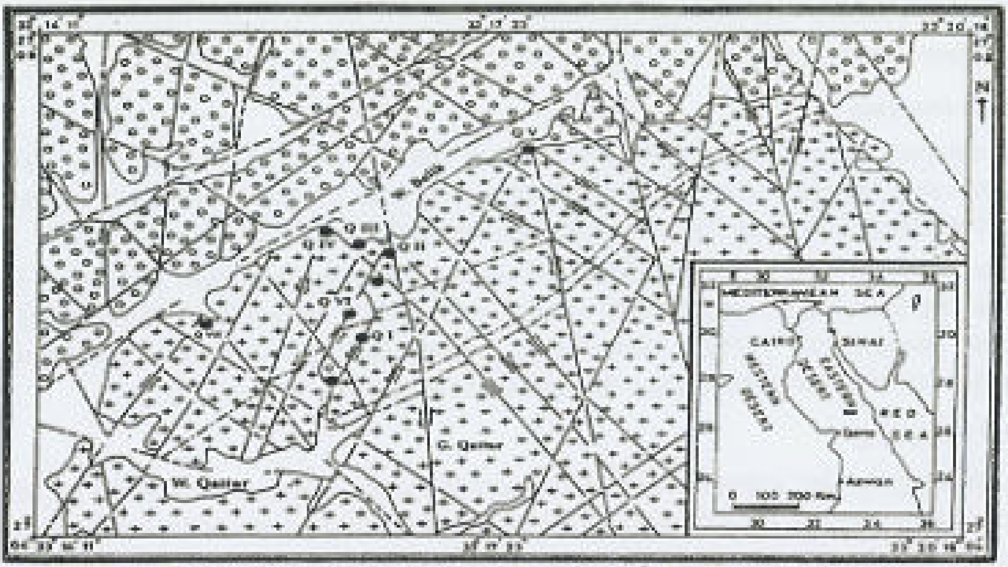


Fig. (1): Geological and structural map of G. Qattar area after Shalaby (1996). The smaller map shows the location of the the study area.

LEGEND

0 1 2Km

Hammamat Sediments.
Pink Granites.
Radioactive Occurrence.
Faults, arrows show relative movements.

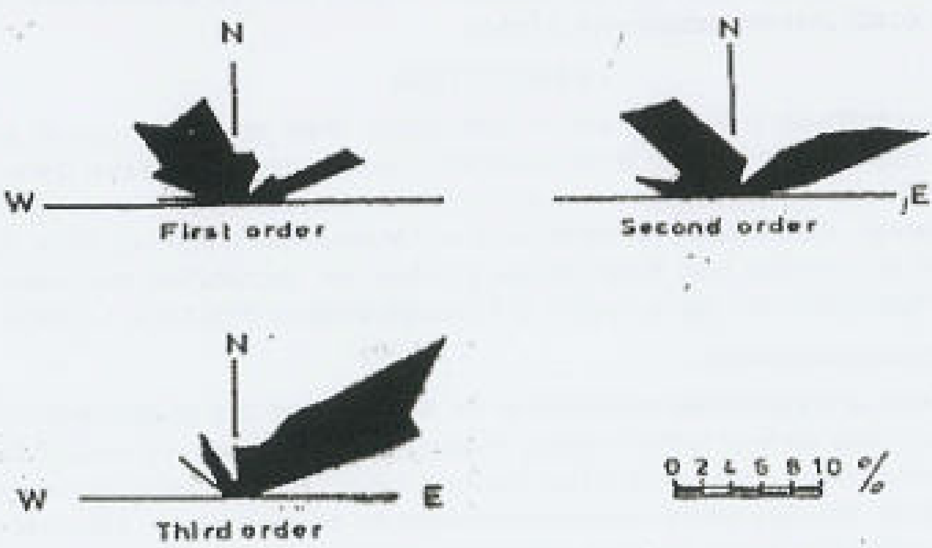


Fig.(2): Rose diagrams showing the trend of wadis in G. Qattar.

MATERIALS AND METHODS

Twenty-six samples of different plant species and soils associated with them were collected from four sectors in Qattar area (Qattar I, II& V). The fourth sector was from Wadi El Abde. These are as follows: nine samples from Qattar I, six samples from Qattar II, five samples from Qattar V and six samples from Wadi El Abde.

1- Plant sampling

Plant samples were collected at blooming duration, these samples were put in paper bags until reaching the lab., then these plants were cleaned from dust in order to be suitable for making experiments. The plant samples were classified in the Flora and Taxonomy Research Department, Agriculture Research Center, Ministry of Agriculture, Giza, Egypt.

2- Plant analysis

Plant samples were dried at 90°C for 4 hrs to remove water. The plant samples were crushed using roll mill. They are then ashed at 550°C for 3 hrs in dry oven to remove the organic matter and to make them in the starting form suitable for chemical analysis.

The plant ash samples are digested and transformed into liquid form using 2 ml HNO_3 acid for one hour, then 6 ml 2:2:2 HCl - HNO_3 - H_2O at 95°C for one hour, then diluted to 20 ml and analyzed by ICP/ES (Inductively coupled plasma / Emission spectrography) techniques to determine some trace and rare earth elements.

3- Soil sampling

The soil samples are collected with the associated plant samples at a depth of 30 cm. The soil samples were put into bags till the lab., and then they were quartered and crushed using a Jio Elaborator into size - 60 mesh. Then they were ground using roll mill till - 200 mesh size.

4- Soil analysis

The soil samples were fused by alkali fusion technique and were analyzed by ICP technique to determine some trace and rare earth elements. All these chemical analyses were carried out at the ACME analytical laboratories, Canada.

VEGETATION

Through the field work in the study area at Gebel Qattar, there are several types of plants, that are condensed in the course of rain water that is coming from top of Gebel Qattar (QI, QII and QV) towards vallies (Figs.3 a, b and c). Family names of some of these plants are *Zygophyllaceae, Brassicaceae, Amaranthaceae and Moringaceae* (Täckholm, 1974). Some plants that are collected from these families for study are: *Zygophyllum coccineum, Zilla spinosa, Fagonia boveana, Aerva javanica and Moringa peregrina* (Figs.3 d, e, f, g and h).

1-*Zygophyllum coccineum*

The presence of *Zygophyllum coccineum* in the Egyptian Red Sea coastal desert is not widespread, being confined to the limestone country rock. It occurs from the seaward fringes of the coastal desert plain to the inland mountain country. The *Zygophyllum coccineum* community of Red Sea coastal area is present within the drainage system. Within the main channels of the larger Wadis, its growth is usually confined to the parts flushed by torrents.

The leaves and stems of this plant are succulent remain green all through the year. Usually xerophyte plants are with cylindrical or ovoid or rarely flattened fleshy leaves. These xerophytes seem to have an age limit of several years. It shrubs up to 75 cm, leaflets 2 cm, bright green, glabrous is cylindrical at least 10 mm long and capsule 8-10 mm long (Fig.3 d).

Zygophyllum coccineum is confined to rainy years when numerous crowded seedlings plants may appear but are eventually thinned to a limited number 1-2/m². In exceptional localities, where the *Zygophyllum coccineum* population may have a higher density, the individuals are usually small being below the normal size of about 0.1m².

2-*Zilla spinosa*

Zilla spinosa is very common in the desert of Egypt. It grows in rock and sandy places. It is the most abundant plant in the majority of the Wadis (Fig.3e). The shoot is blue green dichotomously branched plant with stiff spinescent. Branches and plants often appear to be dead and soon deciduous, fleshy leaves. Plant is typically 50-60 cm high with 8-10 mm broad pods.

3-*Aerva javanica*

Aerva javanica is a white woolly under shrub, erect, densely stellate hairy-leaves, flat, flowers in dense woolly spikes (Fig.3f). It is a xerophyte common in the up stream parts of the Wadis of the Red Sea coastal desert, and is usually found on the slopes of both the coastal hills and foothills, Tackholm (1974).

4-*Fagonia boveana*

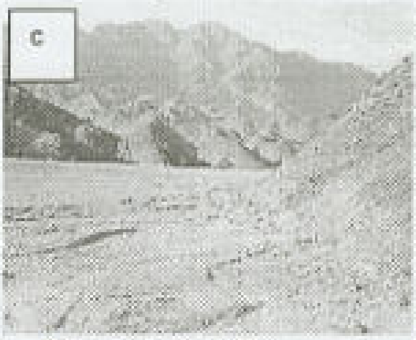
Fagonia tristis sickenb. var. *boveana*, was firstly described by Hadidi (1966) and later modified by the same author as *Fagonia boveana*. This plant is erect hispid shrublet entirely covered with yellowish glands and hairs. Internodes terete, longer (10 mm) or more. Spines as long as leaves, hispid patent or ascending (Fig. 3g). Leaves short petioled. Sepals becoming in fruit and persistent on mature capsules.

5- *Moringa peregrina*

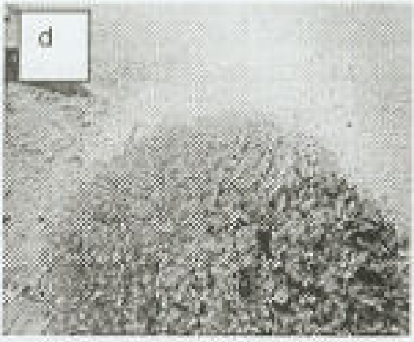
Moringa peregrina is high tree (10-15 m) and usually destitute of leaves. These, when present, consisting of three pairs of long, slender, junci form pinnae, looking like opposite virgate branchlets. Leaflets remote, small, oblong (Fig. 3h). Flowers before the leafing in May, the pendulous pods ripen in October, the angled nut like, white seeds (behen – nuts) are of a bittersweet nauseous taste and rich in oil (ben-oil).

Plants in Wadi of Qattar area.

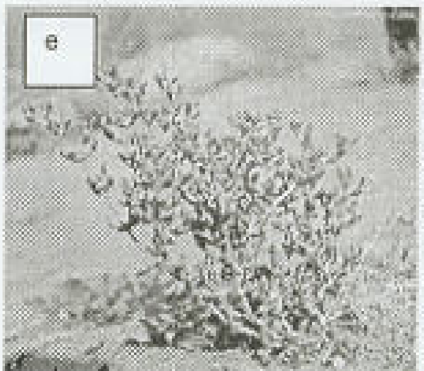
Plant on top of Qattar mountain.



Plants in Wadi Qattar area.

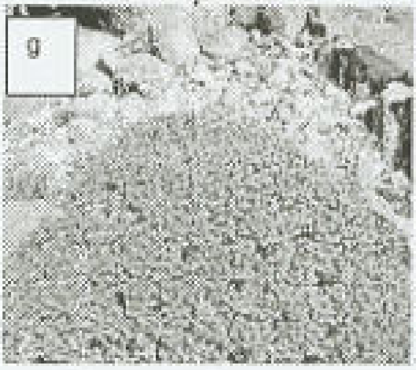


Zygophyllum coccineum,

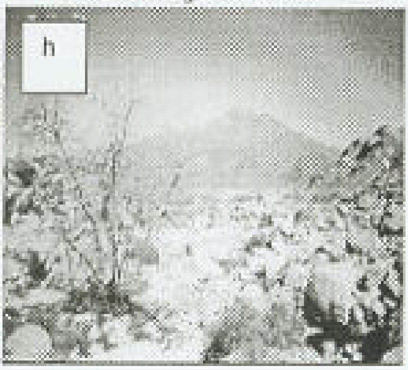


Zilla spinosa.

Aerva javanica.



Fagonia boveana.



Moringa peregrina.

Fig. (3): Types of plants in the study area.

RADIOACTIVITY

Distribution of U, Th, Pb and Mo in Soil Samples:

The collected soil samples for estimating the radioactive elements (mainly U & Th) are products of mechanical weathering of the granites that cover G. Qattar. Some of these products are transformed into soils by processes of chemical weathering. The soil is fine grained suitable for growing plants, which are the main target in the present study. Soil samples were collected from the four localities and prepared for the quantitative determination of U and Th.

Uranium (U):

Uranium distribution in soils of the studied area is nearly equal. The highest value ranges from 6.5 to 6.9 ppm is recorded in the locations QI, QII and QV which are high radioactive areas, while the relative low value 5.1 ppm is recorded in the barren location of Wadi El Abde that is supposed to be non radioactive area (Table 1). This indicates that much of the uranium from the mineralized locations is leached away and transported with solution to Wadi sediments. After this natural leach, U contents in Wadis of both high radioactive and non- radioactive areas look close to each other. This leach can be performed by rain water or by torrents.

Thorium (Th):

Thorium distribution among the studied occurrences shows some variation. This is detected from the highest value 28.6 ppm in QII to 24.2 ppm in QI and 13.5 ppm in Wadi El Abde. The lowest value is recorded in QV 12.9 ppm (Table 1).

Lead (Pb):

Pb distribution in the soils of the studied area reflects association with the highest uranium mineralization. This is shown from the high concentration of uranium and lead in QII location and their low concentrations together in QI, QV and Wadi El Abde (Table 1).

Molybdenum (Mo):

The highest Mo value is recorded in QI occurrence with 0.7 ppm in soil and the lowest value is 0.3 ppm in soil of QV (Table 1). The Mo values range from 0.4 to 0.5 ppm in QII and Wadi El Abde sites.

Table (1): Concentration of U, Th, Pb and Mo (ppm) in soils of the studied area.

Location / Element	Q I	Q II	Q V	Wadi El Abde
U	6.5	6.9	6.6	5.1
Th	24.2	28.6	12.9	13.5
Pb	4.7	11.2	5.5	5.7
Mo	0.7	0.4	0.3	0.5
Th/U Ratio	3.72	4.14	1.95	2.65

Distribution of Elements in Plant Samples:

The ratio (Ep/Es) represents the concentration of a particular element in plant over concentration of the same element in the underlying soil. This ratio represents the uptake of a particular element from soil by plant, and the average of this value in the four localities is called the Index (Ep/Es) Av (Tables 2, 3, 4 and 5).The concentrations of the analyzed U and Th in plants are discussed in the following paragraphs.

Uranium (U):

The value for uptake of uranium element from soils by plant species are represented by the ratio (Up / Us). The highest value of U appearing in *Zilla spinosa* is 0.08 in QI location and 0.09 in Wadi ElAbde location (Table 2). The lowest value 0.001 is recorded in QII site. The average for absorption of uranium element in *Zilla spinosa* is 0.04. The percentage ratio of U concentration (plant / soil) is 4%, which seems to be not significant.

On the other hand, the highest value for the ratio (Up/Us) for *Zygophyllum coccineum* is 0.012 in QI site, while the lowest value is 0.008 in Wadi El Abde site, being 0.003 in QV site (Table 2), and the average for absorption in this species is 0.01. The percentage ratio of U concentration (Up / Us) is 1 %, which is insignificant.

The highest value of the ratio (Up / Us) in *Fagonia boveana* species is 0.27 in Wadi El Abde site, 0.17 in QII site and 0.13 in QI location (Table 2). The lowest value is 0.08 in QV and 0.04 in another sample in QI. The average of this ratio is 0.14. Thus, the percentage ratio of U concentration (Up / Us) in *Fagonia* plant is 14 %, which seems to be significant.

Aerva javanica species uptake of uranium shows sometimes high value among the studied plant species. The ratio (Up/ Us) for this plant is 0.15 in QI site, and the lowest value is 0.01 in QII and Wadi ElAbde locations (Table 2). This species is absent in QV location. The average of this ratio (Up / Us) is 0.05 in this species. The percentage ratio of this species indicating uptake of U from soil is 5 %.

Uptake of U from soil for *Moringa peregrina* is 0.09 in Wadi ElAbde site, and the lowest ratio is 0.01in QII site (Table 2). This species is absent in QI location. The average of the ratio (Up / Us) for this plant species is 0.05. Thus the percentage ratio of (Up/Us) indicating uptake of U from soil by this species is 5 %.

From the previous discussion, it was found that *Fagonia boveana* is able to concentrate uranium element more than the other species such as *Zilla spinosa*, Zygophyluum **coccineum**, Aerva *javanica*.and Moringa *peregrina*, (Fig. 4). Fagonia concentrates U up to 4 times the ability of *Zilla*, up to 14 times of *Zygophyllum*, up to 3 times of *Aerva* and up to 3 times of *Moringa*.

Table (2): Concentration of U (ppm) in ashes of plant samples and soil samples as well as (Up/Us) ratio

Location / Plant	Qattar I*			Qattar II			Qattar V			Wadi El Abde			Index av.	Index av. %
	Plant	Soil	Ratio	Plant	Soil	Ratio	Plant	Soil	Ratio	Plant	Soil	Ratio		
Zilla	0.55 0.21	6.5 6.5	0.08 0.03	0.01	6.9	0.001	0.08	6.6	0.012	0.5	5.1	0.09	0.04	4
Zygophyllum	0.08 0.08	6.5 6.5	0.012 0.012	0.04	6.9	0.006	0.02	6.6	0.003	0.04	5.1	0.008	0.01	1
Fagonia	0.25 0.84	6.5 6.5	0.04 0.13	1.16	6.9	0.17	0.56	6.6	0.08	1.4	5.1	0.27	0.14	14
Aerva	0.2 1.02	6.5 6.5	0.03 0.15	0.08	6.9	0.01	**__	**__	**__	0.06	5.1	0.01	0.05	5
Moringa	**__	**__	**__	0.08	6.9	0.01	0.29	6.6	0.04	0.46	5.1	0.09	0.05	5

Ratio: Ep/Es.

All values except ratios are in ppm.

Index: Average of ratios in the four locations.

*: Two samples are taken from this site.

**: Samples from these sites are absent.

Thorium (Th):

The highest value for absorption of thorium element as represented by (Th p/Th s) in plant *Zilla spinosa* is 0.04 in Wadi El Abde location and 0.03 in QV. The lowest value is 0.002 in QII and 0.01 in QI, and the average for absorption of thorium in this species is 0.02, (Table 3).The percentage ratio of Th concentration of this plant is 2 %, which is regarded as an insignificant ratio.

The highest value of the ratio (Th p/Th s) in *Zygophyllum coccineum* is 0.009 recorded in Wadi El Abde and 0.007 in QII sites. The lowest value is 0.001 recorded in QI site, and 0.002 in QII site (Table 3). The average for uptake of thorium element (Th p/Th s) in *Zygophyllum coccineum* as indicated by the mentioned ratio is 0.004. Thus, the percentage ratio of Th concentration by this plant is 0.4 %, which is insignificant.

On the other hand *Fagonia boveana* plant shows relatively high value for the ratio (Th p/Th s), which equals 0.1 in QII site and 0.08 in QI. The lowest value is 0.02 in QI (two samples are taken from QI location), and 0.04 in QV (Table 3). In Wadi El Abde location, this ratio shows moderate value of uptake between all locations. The average of absorption for this species (Th p /Th s) is 0.06. Accordingly, the percentage ratio of Th concentration by *Fagonia boveana* is about 6 %. It seems to be a significant value for that element.

The uptake of thorium element by *Aerva javanica* plant shows the highest value as given by the ratio (Th p / Th s) that equals 0.4 in QI site, and the lowest value is 0.01in QI and QII, and 0.02 in Wadi El Abde (Table 3). It is noted that the sample of this species is absent in QV. The average for Th absorption is 0.11, and the percentage ratio of thorium concentration by *Aerva* is 11 %. It seems to be a significant ratio of absorption of Th.

The highest value of the ratio (Th p / Th s) for *Moringa peregrina* plant is 0.15 in Wadi El Abde, and 0.09 in QV (Table 3). The lowest value is 0.007 in QII location. The sample for this species is absent in QI location. The average for uptake of Th is 0.08, and the percentage ratio of thorium element concentration is 8 %, which seems to be a significant ratio.

From the previous results, it was found that, the plant species that can concentrate thorium element are *Aerva javanica* and *Moringa peregrina*, (Fig. 5) Thus, these plants are significant for exploration of thorium. On the other hand, *Zygophyllum coccineum* is unable to absorb and concentrate the two elements U and Th. Thus, this plant is insignificant as an index plant for exploration of uranium and thorium.

Table (3): Concentration of Th (ppm) in ashes of plant samples and soil samples as well as (Thp/Ths) ratio.

Location / Plant	Qattar I*			Qattar II			Qattar V			Wadi El Abde			Index av.	Index av. %
	Plant	Soil	Ratio	Plant	Soil	Ratio	Plant	Soil	Ratio	Plant	Soil	Ratio		
Zilla	0.32 0.63	24.2 24.2	0.01 0.02	0.06	28.6	0.002	0.39	12.9	0.03	0.56	13.5	0.04	0.02	2
Zygophyllum	0.06 0.02	24.2 24.2	0.002 0.001	0.21	28.6	0.007	0.02	12.9	0.002	0.13	13.5	0.009	0.004	0.4
Fagonia	0.45 2.1	24.2 24.2	0.02 0.08	3.27	28.6	0.1	0.48	12.9	0.04	0.65	13.5	0.05	0.06	6
Aerva	0.34 11.9	24.2 24.2	0.01 0.4	0.35	28.6	0.01	**__	**__	**__	0.22	13.5	0.02	0.11	11
Moringa	**__	**__	**__	0.21	28.6	0.007	1.25	12.9	0.09	2.07	13.5	0.15	0.08	8

Ratio: Ep/Es.
All values except ratios are in ppm.
Index: Average of ratios in the four locations.
*: Two samples are taken from this site.
**: Samples from these sites are absent.

Lead (Pb)

The highest value for lead absorption (Pb p/Pb s) from soil in *Zilla spinosa* plant is 0.38 and 0.26 in QI site, (Table 4). The lowest value is 0.006 in QII and 0.01in QV. The average of uptake of this poisonous element as indicated by the ratio (Pb p/Pbs) is 0.15. Accordingly, the percentage ratio of Pb concentration in this plant is 15%, which seems to be a significant ratio.

The highest value for Pb absorption in *Zygophyllum coccineum* as indicated by the mentioned ratio is 0.3 in Wadi El Abde site, and 0.11 in QI site, while the lowest value is 0.02 in QII and in QV sites, (Table 4). The average of absorption of Pb (Pb p/Pb s) is 0.10. Therefore, the percentage ratio of Pb element concentration in this plant is 10%.

Fagonia boveana plant recorded the highest value for Pb absorption in Wadi El Abde site which is 0.46, QI site is 0.43 and QV site is 0.28.The lowest value is 0.12 recorded in QII, (Table 4). The average absorption of Pb element (Pb p /Pb s) is 0.30. Thus the percentage ratio of Pb concentration in *Fagonia boveana* is 30%, which seems to be a significant ratio. This plant should be avoided in cattle herbage.

The highest value for absorption of Pb in *Aerva javanica* is 0.55 in QI site, while the lowest value is 0.06 in QII and 0.1 in Wadi El Abde, (Table 4). The plant sample for this species *(Aerva)* is absent in QV. The average for uptake of this element (Pb p / Pb s) is 0.20, and the percentage ratio of Pb concentration in *Aerva javanica* is 20%, which may be a significant ratio. Rashed (2002) stated that the *Aerva javanica* near gold mine has ability to absorb and accumulate Pb (0.23 ppm) higher than far from gold mine (0.03 ppm) at Wadi Allaqi, Eastern Desert, Egypt. This means that *Aerva* has the ability to concentrate Pb element to some extent from soils enriched with that element.

Moringa peregrina recorded the highest value for Pb uptake in QV site with 0.09 and 0.08 in Wadi El Abde, (Table 4). The lowest value is 0.03 in QII site. The sample of this species is absent in QI location. The average for uptake of lead in *Moringa peregrina* as given by the ratio (Pb p / Pb s) is 0.06, and the percentage ratio of Pb concentration is just 6%, which looks low.

From the previous results, *Fagonia boveana* and *Aerva javanica* plants are able to concentrate Pb element more than the other species. They are arranged in the order: *Fagonia boveana* > *Aerva javanica.* > *Zilla spinosa.* >*Zygophyllum coccineum* > *Moringa peregrine*. Results show also the presence of positive correlation between the two elements uranium and lead in plant samples, (Fig. 6). Therefore *Fagonia* plant can therefore be used to clear soils from extra amounts of U and Pb. This is one of the important results in the present work.

Table (4): Concentration of Pb (ppm) in ashes of plant samples and soil samples as well as (Pb p/ Pb s) ratio.

Location / Plant	Qattar I*			Qattar II			Qattar V			Wadi El Abde			Index	Index
	Plant	Soil	Ratio	Plant	Soil	Ratio	Plant	Soil	Ratio	Plant	Soil	Ratio	Av.	av.%
Zilla	1.80 1.24	4.70 4.70	0.38 0.26	0.07	11.2	0.006	0.07	5.6	0.01	0.66	5.7	0.11	0.15	15
Zygophyllum	0.55 0.20	4.7 4.7	0.11 0.04	0.30	11.2	0.02	0.13	5.6	0.02	1.82	5.7	0.30	0.10	10
Fagonia	0.75 2.06	4.7 4.7	0.15 0.43	1.32	11.2	0.12	1.59	5.6	0.28	2.63	5.7	0.46	0.30	30
Aerva	0.49 2.59	4.7 4.7	0.10 0.55	0.75	11.2	0.06	—**	—**	—**	0.59	5.7	0.1	0.20	20
Moringa	—**	—**	—**	0.37	11.2	0.03	0.54	5.6	0.09	0.5	5.7	0.08	0.06	6

Ratio: Ep/ Es.
All values except ratios are in ppm.
Index: Average of ratios in the four locations.
*: Two samples are taken from this site.
**: Samples from these sites are absent.

Molybdenum (Mo)

The absorption of Mo element in *Zilla spinosa* recorded the highest value of the ratio (Mo p/Mo s) in QI site with 66.52 and 15.31 for the two plant samples that are taken from this location. The lowest value is 1.06 in QV site, but absorption in QII and in Wadi El Abde sites records moderate value with 1.97 and 1.70 respectively, (Table 5). The average for Mo uptake (Mo p/Mo s) for three locations which are: QII, QV and Wadi El Abde is 1.57. The value in QI site only shows that *Zilla* plant concentrates Mo up to 42 and 10 times as the average for all other locations. The percentage ratio of Mo concentration in *Zilla sp.* is 157%.

The highest value of the ratio (Mo p/Mo s) in *Zygophyllum coccineum* is 233.20 and 44.64 in QI location. The lowest value is 0.70, 0.75 and 0.74 in QV, QII and Wadi El Abde sites respectively, (Table 5). The average for Mo absorption (Mo p/Mo s) for the three locations: QII, QV and Wadi El Abde is 0.73. The value in QI site shows that *Zygophyllum* plant concentrates Mo up to 319 and 61 times as the average for all other locations. The percentage ratio of Mo concentration in the species *Zygophyllum* is 73%.

The highest value for Mo absorption in *Fagonia sp.* as represented by the ratio (Mo p/Mo s) is 434.7 in QI and 26.3 in another sample from QI. The value in other locations as QII, QV and Wadi El Abde recorded a range between 2.06 to 2.50, (Table 5). The average for Mo absorption in this species *Fagonia* for three locations: QII, QV and Wadi El Abde is 2.30 and the percentage ratio of Mo concentration in *Fagonia* is 230%. *Fagonia* plant in QI site concentrates Mo up to 189 times (sample of up stream) and 11 times (sample of down stream) relative to the average of all other locations.

Aerva javanica records the highest value of absorption (Mo p/Mo s) in QI with 21.2 and 5.22, (Table 5). The lowest value in Wadi El Abde and QII locations is 0.98 and 1.68 respectively. The sample of this species is absent in QV location. The average for Mo absorption in *Aerva javanica* (Mo p/Mo s) for the two locations: QII and Wadi El Abde is 1.33. The percentage ratio of Mo concentration is 133%. Rashed and Sanzolone (2002) stated that *Aerva javanica* at Wadi Allaqi, has the ability to absorb Mo with 2.0 ppm in dry sample. In the present study *Aerva* recorded 3.7 ppm Mo in one of plant samples collected from Q I location. This last value is close to that recorded by Rashed and Sanzolone.

The highest value for Mo uptake in *Moringa peregrina* as represented by the given ratio is 4.12 in QII and 2.44 in Wadi El Abde locations. The lowest value is 1.66 in QV site, (Table 5).The sample of this species is absent in QI site. The average for Mo absorption as represented by the given ratio is 2.74, and the percentage ratio of Mo concentration in *Moringa peregrina* is 274%.

All values of Mo uptake in QI site are not taken into consideration in calculating the average for Mo absorption because these values are anomalous. This is due to the presence of a near by Mo mine (Mahmoud, 1995).

From the previous results, *Fagonia* and *Moringa* plants are the important plant species, which have the ability for absorption and concentration of Mo element, (Fig. 8).

Table (5): Concentration of Mo (ppm) in ashes of plant samples and soil samples as well as (Mo p/ Mo s) ratio.

Location / Plant	Qattar I #			Qattar II			Qattar V			Wadi El Abde			Index av.	Index av. %
	Plant	Soil	Ratio	Plant	Soil	Ratio	Plant	Soil	Ratio	Plant	Soil	Ratio		
Zilla	10.72 46.57	0.7 0.7	15.31 66.52	0.79	0.4	1.97	0.32	0.3	1.06	0.85	0.5	1.7	1.57	157
Zygophylium	163.3 31.26	0.7 0.7	233.2 44.64	0.3	0.4	0.75	0.21	0.3	0.7	0.37	0.5	0.74	0.73	73
Fagonia	304.33 18.41	0.7 0.7	434.7 26.3	0.94	0.4	2.35	0.75	0.3	2.5	1.03	0.5	2.06	2.30	230
Aerva	14.84 3.66	0.7 0.7	21.1 5.22	0.675	0.4	1.68	—**	—**	—**	0.49	0.5	0.98	1.33	133
Moringa	—**	—**	—**	1.65	0.4	4.12	0.5	0.3	1.66	1.22	0.5	2.44	2.74	274

Ratio: Ep/Es.
#: Ratios for this location (QI) are not taken for average index.
All values except ratios are in ppm.
Index: Average of ratios in the four locations.
**: Samples from these sites are absent.

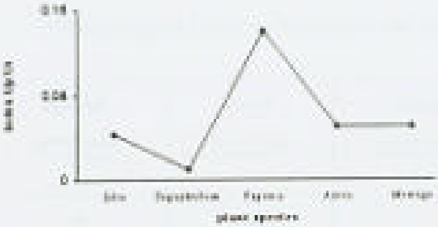


Fig. (4): Frequency curve showing the distribution of U in different plant species.

Fig. (5): Frequency curve showing the distribution of Th in different plant species.

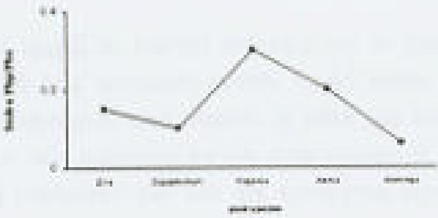


Fig. (6) : Frequency curve showing the distribution of Pb in different plant species.

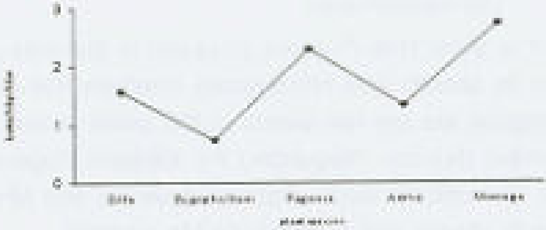


Fig. (7): Frequency curve showing the distribution of Mo in different plant species.

CONCLUSION

There are several types of plants that are grown in the course of running rainwater that is coming from top of Gebel Qattar towards vallies. Sampling sites of these plants are: QI, QII, QV and W. Elabde. Family names of the given plants are: *Zygophyllaceae*, *Brassicaceae*, *Amaranthaceae* and *Moringaceae*. Some plants are collected from these families for study; these are: and *Zygophyllum coccineum*, *Zilla spinosa*, *Fagonia boveana*, *Aerva javanica* and *Moringa peregrina*.

The distribution of the analyzed elements in soil samples of the four localities indicates that Q1, Q11 and QV contain the highest concentration of U and Th relative to Wadi El Abde.

Among the plant samples, it was found from the present work that *Fagonia boveana* is able to concentrate uranium element more than the other species such as *Zilla spinosa* , *Zygophyluum coccineum* , *Aerva javanica* and *Moringa peregrina. The species* Fagonia *boveana* concentrates U up to 4 times the ability of *Zilla*, up to 14 times the ability of *Zygophyllum*, up to 3 times of *Aerva* and *Moringa*. Regarding Th element, the plant species that can concentrate thorium element are *Aerva javanica* and *Moringa peregrina*. On the other hand, *Fagonia boveana* and *Aerva javanica* plants are able to concentrate Pb element. *Fagonia* and *Moringa* plants are the important plants for absorption and concentration of Mo element,

From the previous results, it can be concluded that *Fagonia boveana*, *Aerva javanica* and *Moringa peregrina* plants have the highest ability to absorb and concentrate the radioactive and trace elements: U, Th, Pb and Mo. Thus, these plants are significant for exploration of radioactive and trace elements in the studied area or elsewhere if they are available. Table 6 shows in a relative quantitative manner the U, Th, Pb and Mo contents recorded in each plant species

Table (6): The relative amounts of U, Th, Pb and Mo recorded in each plant species.

Plant / Element	*Zilla spinosa*	*Zygophyllum coccinem*	*Fagonia boveana*	*Aerva Javanica*	*Moringa peregrina*
U	-	-	•	-	-
Th	-	-	-	•	•
Pb	-	-	•	•	-
Mo	-	-	•	-	•

• High concentration.
- Low concentration.

It is clear that *Fagonia boveana* is the only plant in the Eastern Desert of Egypt that is able to absorb and concentrate uranium. On the other hand, *Aerva javanica* and *Moringa peregrina* are the two plants in the same desert that are able to absorb and concentrate the element thorium. Regarding Pb element *Fagonia boveana* and *Aerva javanica* can absorb and concentrate lead. *Fagonia boveana* and *Moringa peregrina* are the two important plants able to absorb and concentrate Mo element.

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الدلائل الحيوية للتنقيب عن اليورانيوم والثوريوم بجبل حتار، شمال الصحراء الشرقية بمصر

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*معهد الدراسات والبحوث الأفريقية - ** هيئة المواد النووية

الهدف الأساسي من هذه الدراسة هو استخدام عناصر البيئة متمثلة في البيئة النباتية والبيئة الأرضية (التربة) في إيجاد طرق جديدة للبحث والتنقيب عن المواد المشعة (اليورانيوم والثوريوم) والعناصر المصاحبة بجانب الطرق التقليدية المستخدمة حاليا وهي طرق إشعاعية وطرق جيولوجية وجيوكيميائية .

تم استخدام ولأول مرة بمصر عدد من النباتات الطبيعية الموجودة في منطقة الدراسة للبحث والتنقيب عن هذه العناصر الكيميائية ومعرفة الأنواع النباتية على وجه الخصوص التي لها القدرة على امتصاص وتركيز المواد المشعة مثل اليورانيوم والثوريوم ، تم التعرف أيضاً على النباتات التي لها القدرة على تجميع وتراكم بعض العناصر المصاحبة مثل : الرصاص والموليبدنيم. حسبت معاملات الامتصاص لكل نبات من النباتات الخمسة المختارة من المواقع الأربعة تحت الدراسة لهذه العناصر التي تم تحليلها كيميائياً وعددها ١٤ عنصراً . علما بأن هذه العناصر تم تحليلها كمياً بكل من النبات و التربة. في النهاية أمكن معرفة مدى قدرة النباتات على امتصاص وتركيز كل عنصر من العناصر المحللة ونسبة هذا التركيز .

توصلت الدراسة الى تجميع عدد خمسة أنواع نباتية من منطقة البحث وهي :

١- زيجوفيلام كوكسينيم — *Zygophyllum coccineum*

٢- زيللا سبينوزا — *Zilla spinosa*

٣- فاجونيا بوفينا — *Fagonia boveana*

٤- إيرفا جافانيكا — *Aerva javanica*

٥- مورينجا بيرجرينا — *Moringa peregrine*

أجريت عملية التصنيف الخاصة بهذه النباتات بقسم النبات التابع لكلية العلوم بجامعة القاهرة بوحدة المعشبة .

يؤخذ في الاعتبار انه تم تجميع هذه الأنواع النباتية من مناطق الدراسة المختلفة وهي منطقة : حتار ١ - حتار ٢ - حتار ٥ ومنطقة وادي العبد . اختيرت منطقة وادي العبد كمكان ضبط لشدة الاشعاع وذلك لكونها خالية من التمعدنات المشعة وغيرها من التمعدنات (أى انها منطقة تمثل الخلفية الاشعاعية) بهدف المقارنة مع المناطق الاخرى (حتار١ وحتار ٢ و حتار٥) التي يوجد بها نسب عالية من العناصر المشعة .

أجرى تحليل العينات النباتية و عينات التربة الخاصة بها تحليلاً كيميائياً كمياً بواسطة الأجهزة الثلاثة التالية:

١- جهاز البلازما ذو التقارن الحثي — Inductively coupled plasma (ICP)

٢- جهاز التحليل الطيفي الضوئي الانبعاثي — Emission spectrography (ES)

٣- جهاز مطياف الكتلة — Mass spectrometry (MS)

يلاحظ أن جميع مواقع الدراسة التي أجرى بها البحث تقع في نطاق منطقة جبل حتار. هذه المنطقة تبعد عن مدينة الغردقة بمسافة ٤٠ كيلو متر بأتجاه الشمال الغربي وهي منطقة جبلية تقع شمال الصحراء الشرقية بمصر.

توصلت الدراسة الحالية الى النتائج الهامة الاتية :

وجد أن نباتات فاجونيا بوفينا وإيرفا جافانيكا ومورينجا بيرجرينا من اكثر النباتات التي لها القدرة على امتصاص العناصر المشعة متمثلة في اليورانيوم والثوريوم و كذلك بعض العناصر المصاحبة الاخرى .

وجد أن نبات فاجونيا بوفينا له القدرة بصفة خاصة على امتصاص و تركيز عناصر: يورانيوم والرصاص وموليبدنم.

أما نبات ايرفا جافانيكا فأن له القدرة بالتحديد على امتصاص و تركيز عناصر : ثوريوم ورصاص ، ومورينجا بيرجرينا له القدرة على تركيز وامتصاص عناصر الثوريوم وموليبدنم

من هذه النتائج يمكن استخدام نبات الفاجونيا بوفينا المتواجد بمنطقة الدراسة مستقبلاً في البحث و التنقيب عن اليورانيوم بباقي المناطق الصحراوية بمصر، و يمكن استخدام نبات ايرفا جافانيكا في البحث و التنقيب عن الثوريوم بالصحراء المصرية . ونبات مورينجا بيرجرينا في البحث و التنقيب عن الموليبدنم. وهكذا يمكن القول ان الدراسة اقتربت من تحقيق الهدف الاساسي للبحث.

ينصح المؤلف رعاة المناطق الصحراوية المصرية بتجنب الاغنام الرعي بالمراعي المليئة بشجيرات الفاجونيا و الايرفا اذا كانت تقع ضمن مناطق غنية بمعادن اليورانيوم والثوريوم. هذا الاجراء ضروري حتى لا تتسبب تلك الظروف في تسمم الماشية ووصول الاشعاع الى جسم الانسان.