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Soil Contamination with Toxic Aluminum at Mid and West Libya

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Abstract

The current study aimed to assessment the soil contamination by toxic Aluminum (Al). The soil samples were collected from Mid and West in Libya, which received man activity waste soil generated from Industrial and Transportation action. The presence of hazardous materials was determined using Neutron Activation Analysis (NAA). The results revealed that the soil samples obtained from four samples mid and west Libya (Qarabulli 6821 mg/kg), (Sokna 1065 mg /kg), (Qaddahia 9761 mg/ kg) and (Khums 4726 mg/kg). The concentrations of Aluminum ranged from1065.mg/ kg to 9761. mg/ kg. The presences of this toxic element in the environment represent high adverse effects on human health, since they might be accumulated in the plants tissue and then transmit into human via food chain.

Keywords: Mid and West Libya and Neutron Activation Analysis (NAA), Soil Contamination, Toxic Aluminum

1. Introduction

Aluminum (Al) is one of the four most common elements occurring in soils. It is one of the most important components of soils, and to the same extent as silicon, it determines the crystalline frame of soil minerals The industrial wastes into the environment represent the main source of soil contamination by several of toxic elements as Aluminum[1]. The adverse effects of Aluminum on the human health and environments have been documented as well[2]. Contamination with Aluminum and its accumulation in plant tissue is the main reasons of its transmission into human via food chain. The present work is the first study done in this field, aimed to explore the level of contaminations by the toxic Aluminum in the soil samples collected from mid and west of Libya adjacent to the industrial wastes generated from man activity and transportation action as shown in Figure 1.

The presence toxic metals like Aluminum in the environment represent real hazards for human health; this is because they have high potential to cause several diseases. It has been established that the presence of toxic metals in the environment, even in low concentrations produce a variety of diseases, respiratory problems and several kinds of cancer[3].

Physical symptoms of Aluminum toxicity may be brittle bones or osteoporosis; also kidney malfunction may also result. Hyperactivity, memory disturbances, and learning disabilities may result from even mildly elevated levels of Aluminum. Aluminum is also found in some seniors with extreme memory loss, absent-mindedness, or dementia. Science has been linking elevation of aluminum in the body with Alzheimer's disease for years[4].

2. Materials and Methods

2.1 Used Technique

In this work, as illustrated in Figure 2, (NAA) was performed with the neutron source Am-Be irradiator facility in thermal mode of neutron flux 1×10^5 (n/cm^2.s). Samples were prepared and packed into pre-cleaned

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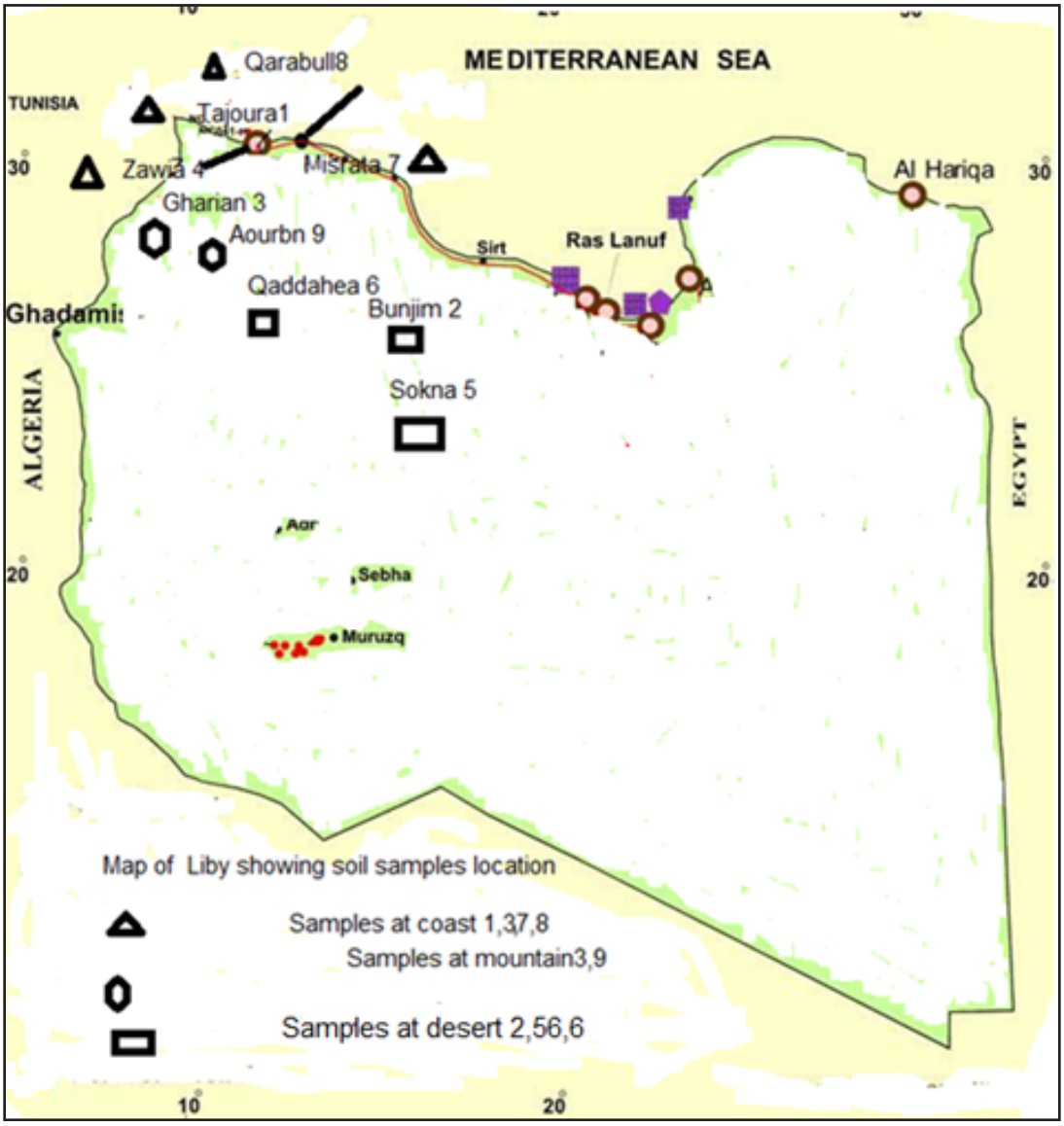


Figure 1. Libyan samples selection regions.

100 ml polyethylene containers. Irradiator with two Am-Be isotopic neutron sources, with the activity of 5 Ci/source, were used for activating the samples with a thermal neutron. The neutron irradiator consists of aluminum tube located between the two Am-Be sources, inside a cylinder (58 cm diameter) of paraffin wax. The samples were irradiated then transferred within 30 s to the counting position.

Auxiliary gamma spectroscopy system, with Hyper Purity Germanium (HPGe) detector of 70% efficiency and 2.1 keV resolution at 1.332 MeV, was used to count the Al decay data after the activation process.

2.2 Study Area

The investigated regions are: 1-Qarabulli east of capital (Tripoli) about 60km 2-Khums east of Tripoli about 120 km where Cement factory is located in this city 3-Sokna 4-Qaddahie (Figure 1). Near Khums, there is Zliten at distance 30 km where second cement factory located. One of cement contents is a the clay that has Aluminum components Al_2O_3[5].

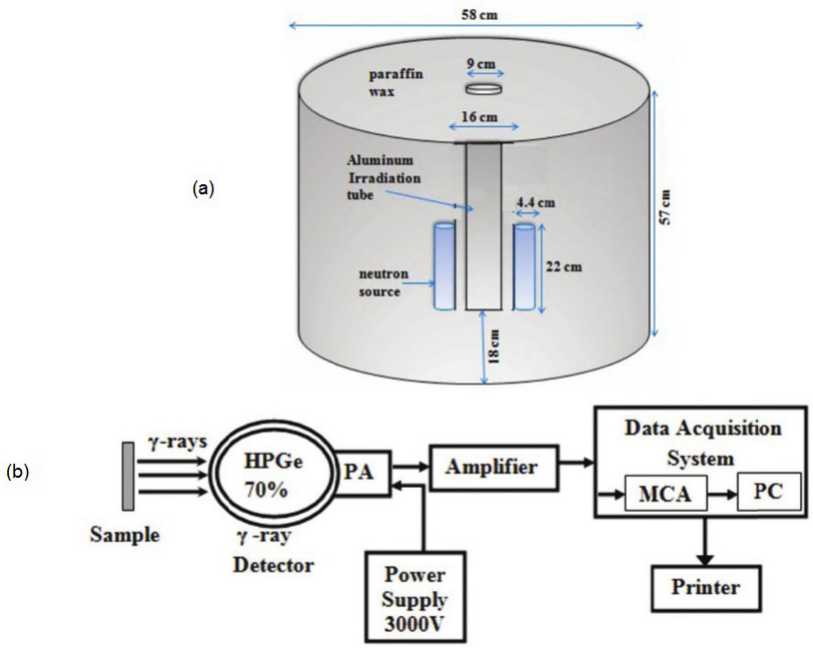


Figure 2: (a) Describes the neutron irradiation facility used through the investigation. (b) Blocked diagram of HPGe g-ray spectrometer system.

The adjacent area of cement factory of Zliten is cultivated with olive oil trees. The olive oil seeds are commonly used by the people and represent a main part for the daily food in the region.

2.3 Collection and Analysis of Soil Samples

Four surface soil samples (0.26–0.33 kg) were collected from Qarabulli, Khums, Sokna and Qaddahie zone. Soil samples were collected at surface level (0–10 cm in depth) from various locations to cover coast, desert, and mountain areas. The soil samples were grounded and sieved. The sieved samples were dried at 70C°/24 hrs. The toxic metals concentrations including Aluminum (Al) was determined using NAA.

Eq (1) was used to directly determine concentration of the desired element in sample using nuclear parameters and important processing times:

$$C = \frac{\lambda A S e^{\lambda t_{cooling}}}{\phi \sigma \theta \varepsilon N_A m I_\gamma (1-e^{-\lambda t_{irr}})(1-e^{-\lambda t_m})} \qquad (1)$$

Where C: The concentration of an element in the sample (ppm); λ: Decay constant = ln(2/T); where T is half-life of Al isotope; A: Atomic weight; S : Net Area under peaks (counts) $t_{cooling}$: cooling time (s); Φ : Neutron flux ($n.cm^{-2}.s^{-1}$); σ : reaction cross section (b = $10^{-24}cm^2$) θ isotopic abundance ε; Efficiency of detector N_A; Avogadro number m; Weight of sample (kg) Iγ; γ-Intensityt_{irr}; Irradiation time (s) t_{count}; measurement time (s). For indirect formation through decay or activation of one of the activation products different formulas have to be used[6].

3. Results and Discussion

In this work the concentrations of Aluminum in soil samples collected from investigated zones were determined. The aim to understand the role of cement factory and transportation action in the contamination of environment and estimate the level of these metals in the surrounding soil. The results are illustrated in Table 1 and Figure 3.

The highest Al content in soil was determined for sample Qaddahia where the concentration of Al is (9761.95 mg/kg), aluminum in high concentrations is very toxic for animals[7], such that Qaddahia is desert region and people possess camels and sheep that would be in risk. While lowest concentration of Al was determined for sample Sokna (1065.95 mg/kg).

This work was compared with other previous works for several countries as tabulated in Table 2 and illustrated in Figure 4.

Table 1. Aluminum distribution over investigated regions

Sample Location	S(count)	T_{irr}(s)	$T_{cooling}$(s)	T_{count}(s)	σ (b)	$T_{1/2}$(s)	Φ (n/cm².s)	Con. of Al (mg/kg)
Qarabulli	600	604800	600	10800	0.230	134.4	5E05	6821
Khums	300	172800	600	10800	0.230	134.4	5E05	4726
Sokna	83	259200	600	10800	0.230	134.4	5E05	1065
Qaddahia	265	604800	600	10800	0.230	134.4	5E05	9761

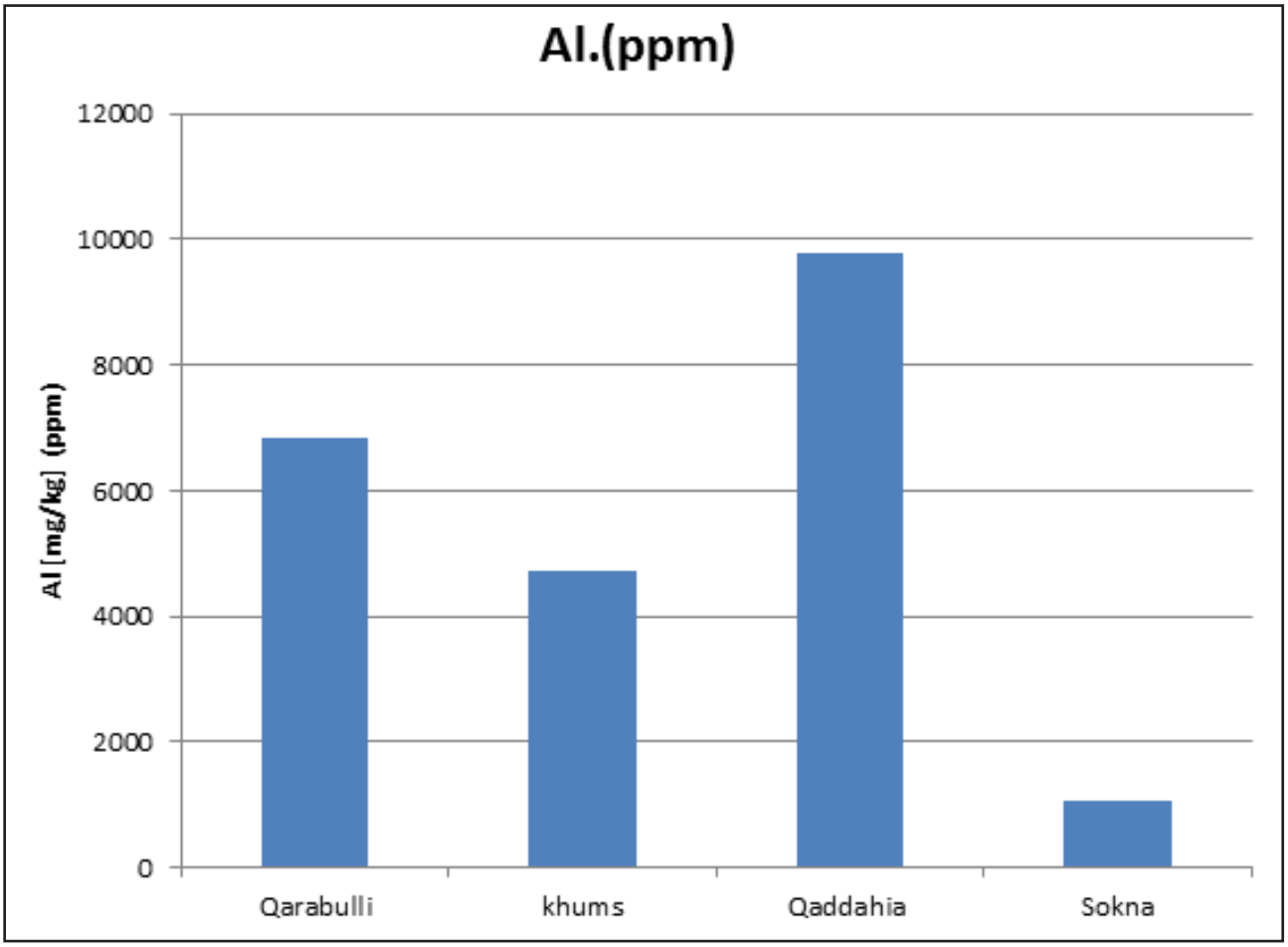


Figure 3. Aluminum distribution over investigated regions.

Table 2. Comparing Al concentration (mg/kg) with other studies for some countries

Country	Reference [8]	Reference [9]	Reference [8]	Reference [10]	Reference [11]	This work for Libya
Egypt		524.				4726 Khums
Ethiopia				286		1065 Sokna
Kuwait			11525			6821 Qarabulli
Nigeria					2064	9761 Qaddahia
Abuja	5860					
Libya (Average)						5839

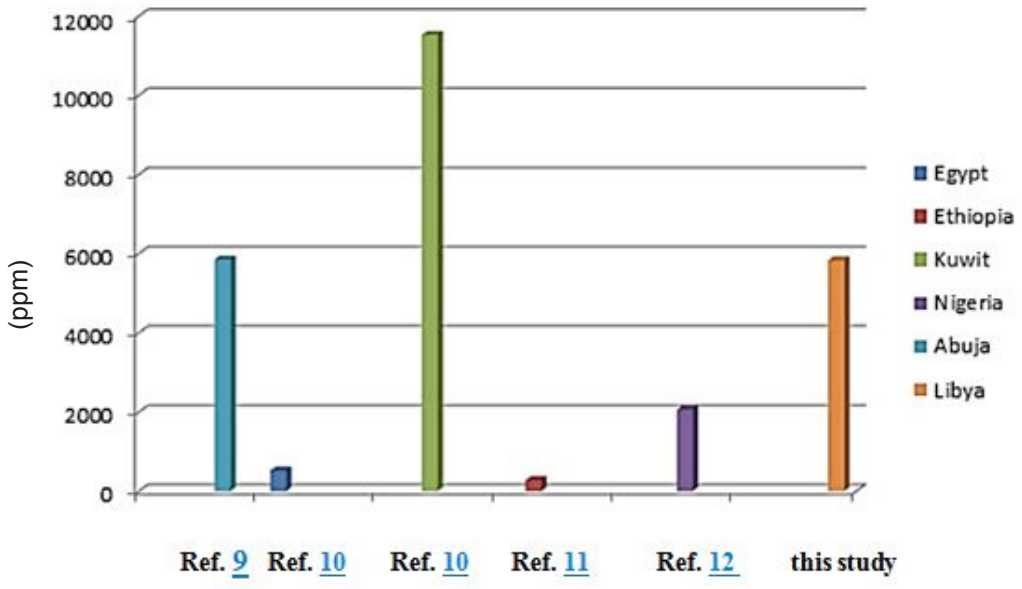


Figure 4. Average aluminum concentrations of Libyan soil samples compared with other world studies.

4. Conclusion

The investigated areas at mid and west, Libya is contaminated with toxic Aluminum. As a Comparison with previous studies for Arabic and African countries evidence good agreement between Abuja and average concentration of Aluminum in Libya while Kuwait indicates highest concentration as shown in Figure 4. The concentrations of toxic Aluminum were generally high and the concerns lie in their accumulation in plants and transmitted into human and animals via food chain. Therefore, the soil should not be used for agriculture until it be cleaned up for insure the human health.

As a simple solution, to overcome this problem; these regions must be reclaimed before planting of this excess of Al level, as been recommend that; this soil should be used only for planting certain types of plants that do not absorb aluminum from soil.

In this work Author suggested that to remove Aluminum toxicity from soil; using dolomitic limestone, which contains both calcium and magnesium carbonate, should be proceed on acidic soils that are magnesium deficient. Additionally, proper soil pH (Acidity degree) is important to promote favorable microbial activity and maximize the availability of micronutrients.

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