

## Heavy Metals and Microbial Analysis of Soil Samples Collected from Aramco Gulf Operations Company Al-khafji, (AGOC) Saudi Arabia

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### Abstract

Soil samples were collected from Aramco Gulf operations Company (AGOC), Al-Khafji town, Saudi Arabia. Soil metals and microbial contents were determined. The obtained results revealed that all soil samples were sandy in texture, mildly alkaline in reaction and containing low amount of organic matter which ranged between 0.48 – 0.98 %. Total soluble salts ranged from 5.8 to 13.18 % and soil pH ranged between 8.3-9.2 and revealed no appreciable differences within localities. Soil samples differ in their mineral content. All tested localities contained high amounts of lead followed by manganese, cadmium, cobalt, and nickel. Isolated microbial flora consists of eight fungal genera belonging to *Alternaria*, *Aspergillus*, *Cladosporium*, *Curvularia*, *Fusarium*, *Penicillium*, *Trichoderma* and *Ulocladium* and four bacterial genera belonging to, *Bacillus*, *Corynebacterium*, *Listeria* and *Staphylococcus*.

**Key words:** Pollution, Heavy metals, soil composition, soil microbial flora, Al-Khafji, Saudi Arabia.

### Introduction

Soil samples are differed in their content of Cd, Co, Mn, Ni, and pH depending in climate soil origin composition and human activities. In recent years, heavy metals in the soil have received attention as environmental contaminants because of their extended persistence, and toxicity to many organisms (Hashem & Al-Obaid 1996), Microbial transformation of heavy metals play also very important role in the environmental pollution (Hashem & Al-Obaid 1996).

There are several problems dealing with heavy metals contaminated soils which effect human health and environmental quality. The anthropogenic sources of the heavy metals, in soils are either primary sources, i.e. the heavy metals are added to the soil as an outcome of working the soil, such fertilization or secondary sources where heavy metals are added to the soil as a consequence of a nearby activity, such as

smelting or aerosol deposition Ferguson (1990). The Soil content of heavy metals are often cover a wide range and it is frequently difficult to determine the source of the elements. The present study was carried out to determine the soil composition of heavy metals and microbial flora from different sites of Al-Khafji city in Saudi Arabia.

### Materials and Methods

Al-khafji town is located in the northeastern part of Saudi Arabia, about 350 Km from damam city (Fig. 1). Soil samples were collected, from six different sites at a depth of 1.30 cm, four samples from each site, on summer season of 2005 from AGOC, in Al-Khafji town. Soil texture were determined according to the method described by Johnson *et al.* (1966). The soil organic matter, total soluble salts, and pH value were determined according to Piper (1977) and Black *et al.* (1965). Metals were determined according to

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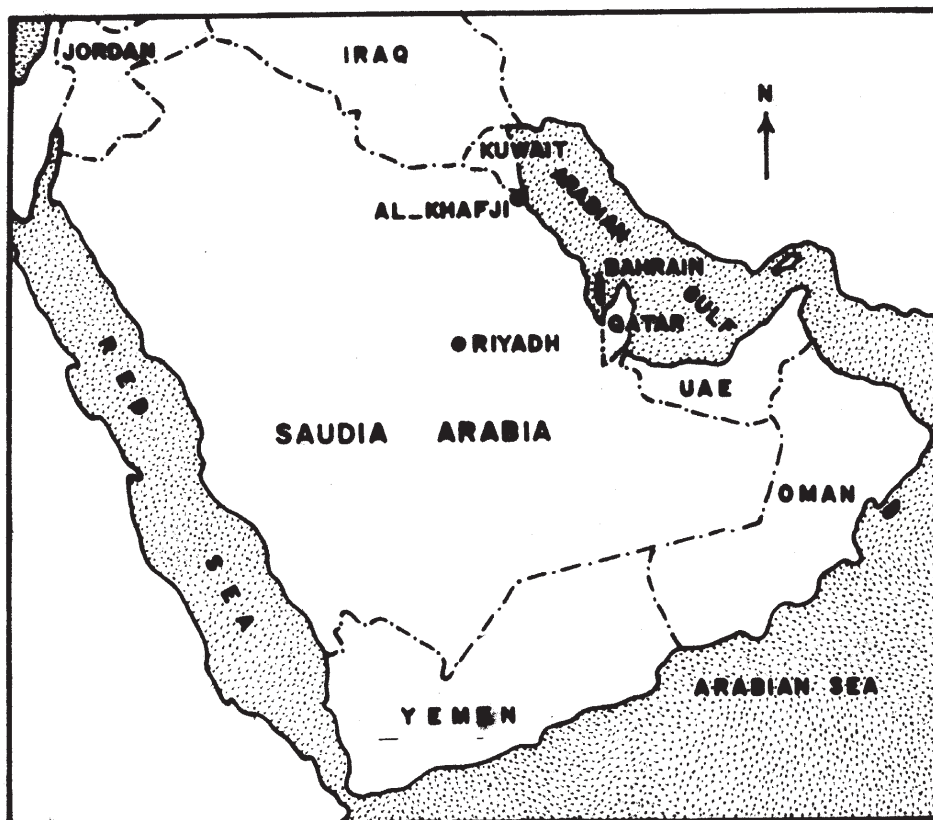


Fig 1. Location of Al-Kharj town in the map of Saudi Arabia.

Hashem (1990). Total number of fungi and bacteria per gram of soil were counted by using the dilution plate method for each type of soil samples as described earlier by Hashem (1996).

## Results and Discussion

Results of soil analysis are given in Table (1). Soil samples were sandy in texture and low in organic matter the organic matter (ranged from 0.48% to 0.98%). Total soluble salts ranged from 5.8% to 13.18% and the pH values of the soil samples revealed no appreciable differences at all localities, soil reaction was alkaline, pH values ranged from 8.3 to 9.2. The effect of organic matter in soil samples was negligible, since all samples contained very low amounts of organic matter, this result is consistent with other finding of earlier studies on Saudi Arabian soils (Hashem, 1993a; Hashem, 1993b; Hashem and Parvez, 1994). (Table 2) shows that the soil samples

from different localities differ in their metals content. All tested localities contained the highest amounts of lead followed by manganese, cadmium, cobalt, and nickle. Pollution of soil by heavy metals occurs due to different sources such as industrial wastes, application of fertilizers, corrosion of sheeting, wires, pipes, burning of coal and wood, and fuel hydrocarbons. Soil heavy metals content from different places of the world are well known (Ehrlich, 1981; Anderson, 1977; Brown, 1975; Dudas and Dowluk, 1977; Pendas and Pendas, 1985; Davies, 1980), while no information concerning metal and microbial analysis of Al-Khafji area, Saudi Arabia.

The total number of fungal and bacterial colonies per gram of soil is shown in Table 3. Different soil localities support the growth of eight fungal and four bacterial genera (Table 4).

*The fungal genera are Alternaria, Aspergillus, Cladosporium, Curvularia, Fusarium,, Penicillium,*

**Table 1.** Soil type, organic matter, total soluble salts, and pH values of different localities (n=5). From Alkhafji, Saudi Arabia.

Locality	Soil type	Organic matter %	Total soluble salt	pH value
Fire station zone	Sandy	0.53	11.11	8.5
Desalter plant area	Sandy	0.95	13.18	8.3
Cooling tower area	Sandy	0.61	8.89	8.1
Khafji storage area	Sandy	0.48	7.63	8.9
Ratawi storage area	Sandy	0.78	10.39	9.0
Fire station center	Sandy	0.92	5.80	9.0
Material stock yard	Sandy	0.98	9.89	8.7
Explosive storage area	Sandy	0.90	12.11	9.2

**Table 2.** Mineral content ( $\mu\text{g}^{-1} \text{g}$ ) of different soil localities (n=5,  $\pm$  standard deviation). From Alkhafji, Saudi Arabia.

Locality	Metal content ( $\mu\text{g}^{-1} \text{g}$ )				
	Cd	Co	Ni	Mn	Pb
Fire station	9.7 $\pm$ 0.63	4.0 $\pm$ 0.61	3.9 $\pm$ 0.13	5.7 $\pm$ 0.65	17.4 $\pm$ 1.3
Desalter plant area	9.8 $\pm$ 0.89	4.1 $\pm$ 0.63	3.3 $\pm$ 0.15	7.1 $\pm$ 0.81	20.8 $\pm$ 1.6
Cooling tower area	14.1 $\pm$ 1.13	6.3 $\pm$ 0.65	4.9 $\pm$ 0.25	14.8 $\pm$ 1.21	26.8 $\pm$ 1.8
Khafji storage area	13.0 $\pm$ 1.01	5.3 $\pm$ 0.85	4.5 $\pm$ 0.13	19.2 $\pm$ 1.01	25.3 $\pm$ 1.3
Ratawi storage area	15.9 $\pm$ 1.11	8.0 $\pm$ 0.98	4.1 $\pm$ 0.12	14.2 $\pm$ 1.0	27.9 $\pm$ 1.9
Fire training center	12.9 $\pm$ 1.13	6.3 $\pm$ 0.31	3.0 $\pm$ 0.11	22.3 $\pm$ 1.01	25.4 $\pm$ 1.6
Material stock yard	7.8 $\pm$ 0.61	3.6 $\pm$ 0.21	3.9 $\pm$ 0.31	7.8 $\pm$ 0.61	13.5 $\pm$ 0.98
Explosive storage area	11.3 $\pm$ 1.05	5.4 $\pm$ 0.51	3.2 $\pm$ 0.21	4.7 $\pm$ 0.13	22.9 $\pm$ 1.11

**Table 3.** Number of fungal and bacterial colonies per gram of soil from Alkhafji, Saudi Arabia.

Locality	Number of colonies per gram of soil	
	Fungi	Bacteria
Fire station no. 2	835 $\pm$ 4	2.1 $\times 10^6$
Desalter plant area	1561 $\pm$ 8	3.8 $\times 10^6$
Cooling tower area	1391 $\pm$ 6	2.7 $\times 10^6$
Khafji storage area	1138 $\pm$ 6	5.4 $\times 10^6$
Ratawi storage area	989 $\pm$ 4	4.1 $\times 10^6$
Fire station center	1013 $\pm$ 5	5.2 $\times 10^6$
Material stock yard	1311 $\pm$ 7	3.9 $\times 10^6$
Explosive storage area	1568 $\pm$ 8	5.01 $\times 10^6$
Average	1225	4.02 $\times 10^6$

**Table 4.** Fungal and bacterial genera isolated from different localities. From Alkhafji, Saudi Arabia.

Fungi	Bacteria
<i>Alternaria</i> sp.	<i>Bacillus</i> sp.
<i>Aspergillus</i> sp.	<i>Corynebacterium</i> sp.
<i>Cladosporium</i> sp.	<i>Listeria</i> sp.
<i>Curvularia</i> sp.	<i>Staphylococcus</i> sp.
<i>Fusarium</i> sp.	
<i>Penicillium</i> sp.	
<i>Trichoderma</i> sp.	
<i>Ulocladium</i> sp.	

*Trichoderma* and *Ulocladium* isolated in the present study, such genera were previously reported in different Saudi Arabian soils (Abdel-Hafez, 1982; Ali, 1977; Hashem, 1997; Hashem, 1993a; Hashem, 1993b; Hashem and Parvez, 1994; Hashem and Moslem, 1995). While the bacterial genera isolated in the present investigation consist of *Bacillus*, *Corynebacterium*, *Listeria*, and *Staphylococcus*, were also reported in different Saudi Arabian soil (10). The effect of organic matter, total soluble salts, pH value, and metals on soil microbial flora are severally different from place to another. Overall, heavy metals were generally toxic to soil microbial flora, but some microorganisms appeared to benefit from some concentrations (Ross, 1981). Much need to be studied about soil analysis, microbial flora, mineral content, wild plants, and sludge analysis in Al-Khafji area.

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## تحليل المعادن الثقيلة و الكائنات الحية الدقيقة لعينات التربة من منطقة عمليات شركة ارامكو الخليج بالخفجي - المملكة العربية السعودية

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### الملخص

جمعت عينات التربة من منطقة عمليات شركة ارامكو الخليج بمدينة الخفجي من المملكة العربية السعودية. قدر محتواها من المعادن الثقيلة و الاحياء الدقيقة. أظهرت نتائج التحليل للتربة انها ذات قوام رملي و متوسطة في القلوية و تحتوي في الغالب علي نفس الكمية من المادة العضوية والتي تراوحت ما بين ٤٨ ، ٠ - ٩٨ ، ٠٪. و تراوحت قيم الاملاح الذائبة الكلية بها ما بين ٨ ، ٥ - ١٨ ، ١٣٪. أوضحت نتائج ال pH للتربة عدم وجود فروقات واضحة بين المواقع حيث تراوحت ما بين ٧ ، ٧ - ٨ ، ٢ ، ٩. كما أوضحت نتائج التحليل المعدني تباين في المحتوي المعدني للمواقع المدروسة فجاء الرصاص في المرتبة الاولي تبع بالمنجنيز فالكاديوميوم و الكوبلت ثم النيكل. اما الفلورا للكائنات الحية الدقيقة المعزولة من التربة فوجود انها تتبع ثمانية اجناس فطرية تنتمي الي كل من :  
*Alternaria, Aspergillus, Cladosporium, Curvularia, Fusarium, Penicillium, Trichoderma and Ulocladium* و  
و أربع اجناس بكتيرية تنتمي الي كل من :

*Bacillus و Corynebacterium, Listeria and Staphylococcus.*