

## **Analysis of Water and Soils from Ashafa, Toraba, Wahat and Wehait**

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**Abstract.** Soil and water samples from Ashafa, Toraba, Wahat and Wehait (Saudi Arabia) were collected and analysed chemically for their macro- and micro-elements. Water samples from these places closely resemble each other in the concentrations of aluminium, bromide, calcium, chloride, copper, fluoride, iron, magnesium and zinc, while soil samples differ slightly.

### **Introduction**

The ecology of a site is influenced markedly by its soil, which differs in its constituent from place to place [1]. Although this variation occurs naturally, non-natural means, such as burning coal, oil, wood and urban wastes also cause variation in the mineral constituents of soil [2,3]. Pollution by heavy metals also occurs due to industrial wastes, application of fertilizers and fungicides, corrosion of sheeting, wires, pipes and other equipments [2,4,5]. A high quantity of heavy metals in soil and water is reported to have toxic effects on both plants and animals [6,7,8]. In Australia 30,000 hectares of agricultural land, which had been in use for apple and pear cultivation, were banned due to contamination by high quantities of As, Cu and Pb [4].

The present study was planned to establish the macro- and micro-nutrient constituents of the soil and water of Ashafa, Toraba, Wahat and Wehait. The water of these places is brought to several millions pilgrims, who gather each year in the city of Holy Makkah to perform Haj.

## Materials and Methods

### A. Water analysis

The methods for sampling water were similar to those described by SASO [9]. Samples of water from the different wells of Ashafa, Toraba, Wahat and Wehait (Fig. 1) were collected in 100-ml polyethylene plastic bottles with screw caps. These bottles were washed thoroughly with distilled water and dried prior to collection of samples. The procedures for mineral analysis of water were the same as described for soil analysis later. Five samples of water from each place and five replicates of each water sample were taken for mineral analysis. The samples were kept in the refrigerator at 5°C on arrival in the laboratory until further analysis.

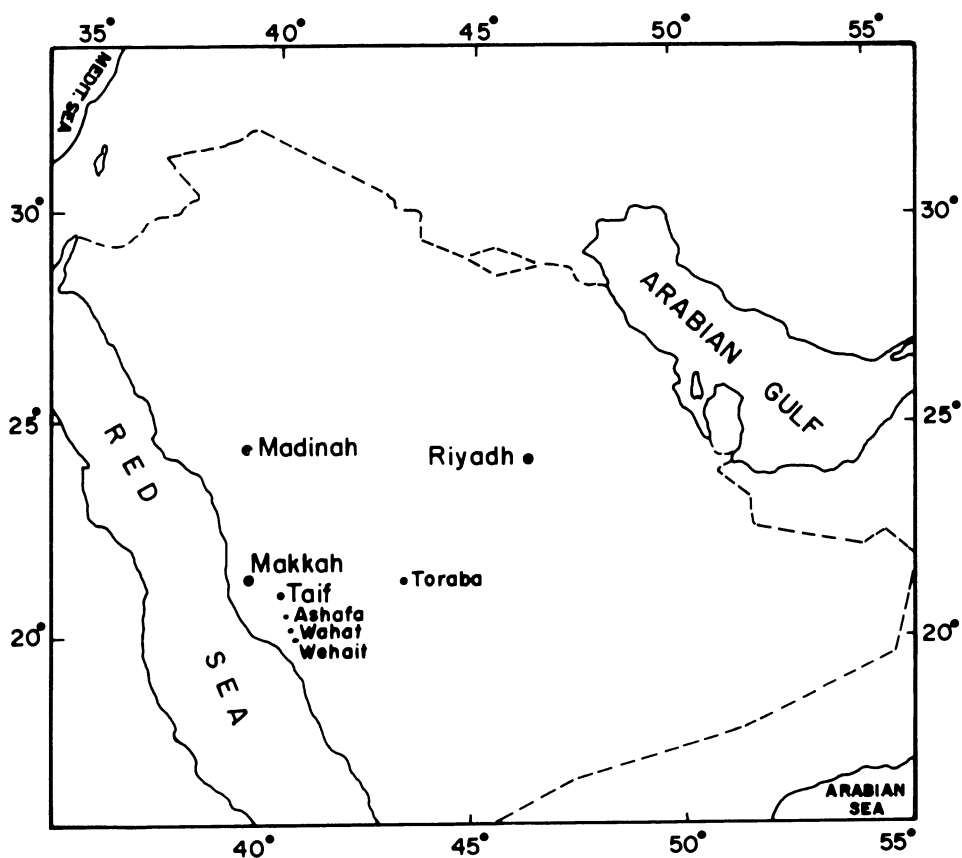


Fig. 1. Map showing the sites at which the samples were taken

## B. Soil analysis

Soil samples were collected from an exposed soil surface. In each case the soil was scraped [1-5 cm depth) into a plastic bag using a stainless steel spoon. On arrival in the laboratory all samples were passed through a 2.0 mm sieve and were digested in concentrated analar nitric acid to obtain a measure of total metal content. The procedure was as follows: 0.5 g of air dried soil was placed in a 100-ml beaker with 15 ml concentrated nitric acid, covered with a watch-glass and heated at 95-100°C for 15 min. After digestion, the digest were made up to 50 ml with deionised water and analysed using an atomic absorption spectrophotometer Perkin-Elmer Model 3030 [10,11], for determining Al, Br, Cu, Fe and Zn. Chloride was determined by the silver nitrate method [12]. Calcium and Mg were determined by atomic absorption flame spectrophotometer (Pye Unicam sp9 equipped with sp9 computer). Fluoride was determined by Orion research ion analyser (01A digital pH/mv meter). Five soil samples were collected from each place and five replicates of each sample were used for mineral analysis.

## Results

The results of water analysis are summarized in Table 1. The water from Ashafa, Toraba, Wahat and Wehait resemble each other quite closely in their mineral composition. The results of soil analysis are summarized in Table 2. The soils from the four places differ slightly in their composition. Soil from Wahat contained the highest amount of Al, followed by Toraba. Toraba soil was found to be richer in Ca content, while soil of Wheat contained more Cu, Mg, Zn and Fe.

## Discussion

The presence of Al in trace amount in all samples resembles the findings of Mengel and Kirkby [13]. The concentrations of Ca and Fe in the water were below the upper limits of Saudi Arabian Standard Organization (SASO) recommendations [9] and International Standard (IS) [14] for drinking water. The concentrations of  $\text{Cl}^-$ , Cu,  $\text{F}^-$ , Mg and Zn were less than optimum concentrations recommended by SASO [9] and IS [14], Table 3.

Calcium is a necessary element for the growth of humans, animals and plants [15,16,17] while  $\text{Cl}^-$  is a mobile element and easily lost by leaching under freely drained conditions [13], but a high concentration of  $\text{F}^-$  becomes toxic [18].

The concentrations of Al found in this study were similar to earlier findings [19,20]. The concentrations of  $\text{Br}^-$  is less than reported earlier [21,22].

**Table 1. Mineral content ( $\text{mg L}^{-1}$ ) of water samples ( $n = 5$ ) from different sources ( $\pm$  standard deviation).**

Element	Ashafa	Toraba	Wahat	Wehait
Aluminium	$0.03 \pm 0.01$	$0.06 \pm 0.02$	$0.08 \pm 0.02$	$0.05 \pm 0.01$
Bromide	$0.11 \pm 0.04$	$0.23 \pm 0.01$	$0.28 \pm 0.01$	$0.15 \pm 0.01$
Calcium	$63.68 \pm 2.06$	$67.45 \pm 3.6$	$57.65 \pm 2.6$	$48.85 \pm 3.6$
Chloride	$18.06 \pm 1.8$	$15.53 \pm 2.01$	$16.97 \pm 1.3$	$15.81 \pm 1.3$
Copper	$0.01 \pm 0.004$	$0.04 \pm 0.01$	$0.02 \pm 0.01$	$0.01 \pm 0.005$
Fluoride	$0.65 \pm 0.01$	$0.60 \pm 0.02$	$1.19 \pm 0.8$	$0.26 \pm 0.006$
Iron	$0.06 \pm 0.002$	$0.31 \pm 0.03$	$0.23 \pm 0.05$	$0.38 \pm 0.04$
Magnesium	$14.01 \pm 1.6$	$13.85 \pm 2.6$	$13.65 \pm 2.5$	$11.15 \pm 1.99$
Zinc	$0.11 \pm 0.01$	$0.15 \pm 0.09$	$0.13 \pm 0.01$	$0.10 \pm 0.01$

**Table 2. Mineral content ( $\mu\text{g g}^{-1}$ ) of soil samples ( $n = 5$ ) from different sources ( $\pm$  standard deviation).**

Element	Ashafa	Toraba	Wahat	Wehait
Aluminium	$100 \pm 1.69$	$200 \pm 1.52$	$230 \pm 2.5$	$150 \pm 2.64$
Bromide	$0.25 \pm 0.03$	$0.10 \pm 0.01$	$0.16 \pm 0.02$	$0.30 \pm 0.01$
Calcium	$3510 \pm 5.0$	$3800 \pm 5.50$	$3000 \pm 3.86$	$3200 \pm 4.83$
Chloride	$0.11 \pm 0.03$	$0.076 \pm 0.02$	$0.17 \pm 0.02$	$0.22 \pm 0.01$
Copper	$12.3 \pm 1.22$	$11.7 \pm 3.11$	$5.8 \pm 0.62$	$21.7 \pm 2.62$
Fluoride	$0.20 \pm 0.01$	$0.13 \pm 0.02$	$0.25 \pm 0.04$	$0.17 \pm 0.02$
Iron	$28 \pm 1.02$	$35 \pm 2.61$	$43 \pm 2.62$	$45 \pm 3.16$
Magnesium	$2060 \pm 5.63$	$2330 \pm 4.81$	$2389 \pm 3.98$	$3361 \pm 4.06$
Zinc	$9.2 \pm 1.26$	$6.8 \pm 2.21$	$8 \pm 1.65$	$10.4 \pm 2.31$

**Table 3. Limits of mineral concentration of unbottled drinking water. (According to Saudi Arabian and International Standards of drinking water).**

Element	Optimum (mg L <sup>-1</sup> )	Maximum (mg L <sup>-1</sup> )
Calcium (as Ca)	75	200
Chloride (as Cl)	200	600
Copper (as Cu)	0.05	1.5
Fluoride	0.6	2
Iron	0.1	1.0
Magnesium	*Not more than 30 mg L <sup>-1</sup> if there is 250 mg L <sup>-1</sup> sulphate; if there is less sulphate, magnesium up to 150 mg L <sup>-1</sup> may be allowed.	150
Zinc (as Zn)	5	15

Soil analysed for Cl showed low Cl<sup>-</sup> contents and this may be because Cl<sup>-</sup> in soil is not absorbed by minerals and ions of the most mobile elements are lost easily by leaching [13,23]. The concentrations of Cu in the above soil resemble earlier findings [24,25]. Soil analysed for F<sup>-</sup> contained low F<sup>-</sup> content; the low concentration of F<sup>-</sup> in the soil might be due to the alkaline pH of soil [26,27], although the average concentration of F<sup>-</sup> in soil is in between 20-360  $\mu\text{g g}^{-1}$  [28,29,30]. According to Mengel and Kirkby [13], Fe<sup>-</sup> makes up about 5% by weight of the earth's crust and is invariably present in all soils, typical soils have levels ranging from 30 to 550  $\mu\text{g g}^{-1}$ , whereas very acidic soils can exceed 2000  $\mu\text{g g}^{-1}$ . Concentration of Fe<sup>-</sup> in soils analysed in the present study ranged from 28 to 43  $\mu\text{g g}^{-1}$ . The Mg content of most soils generally lies in the range between 0.05% for sandy soils and 0.5% for clay soils [13]. According to Mengel et al. [31], Mg<sup>++</sup> in soils is present in fairly high concentrations and often between 170-400  $\mu\text{g g}^{-1}$  although the levels can vary considerably and values between 17-13000  $\mu\text{g g}^{-1}$  have been reported. Magnesium content in all sources was present in relatively high amounts.

The mean Zn content in surface soils of different countries ranges from 17 to 125  $\mu\text{g g}^{-1}$  [32,33,34,35,36], but Zn content in the present study ranged from 6.0 to 10  $\mu\text{g g}^{-1}$ .

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## تحليل الماء والتربة لكل من منطقة الشفا، تربة، الوهط والوهيط

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المملكة العربية السعودية

(استلم في ١٨ رجب ١٤٠٨هـ، قبل للنشر في ٢٣ ربيع الآخر ١٤١٠هـ)

ملخص البحث. جمعت عينات من التربة والماء من منطقة الشفا، تربة، الوهط والوهيط (المملكة العربية السعودية) وحللت لتقدير المحتوى لبعض العناصر المعدنية.

أظهرت نتائج التحليل أن المحتوى المعدني للماء متشابه في جميع المناطق بالنسبة للألومنيوم والبروميد والكالسيوم والكلوريد والنحاس والفلوريد والحديد والمغنيسيوم والخارصين بينما المحتوى المعدني للتربة في المناطق السابقة يختلف عن بعضها البعض.