

DETERMINATION OF CONCENTRATIONS OF SELECTED RADIONUCLIDES IN SURFACE SOIL IN THE STATE OF KUWAIT

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INTRODUCTION

Exposure from radioactive nuclides of terrestrial origin has remarkable input to the total effective dose equivalent for human population. The substantial part of this exposure is external irradiation, which depends on activity mass concentration of primordial radionuclides in surface soil, mainly ²³⁸U, ²³²Th series and long-lived ⁴⁰K. From geological point of view the surface soil of Kuwait is relatively uniform: desert type with prevailing smooth sand sheets and one cannot expect the big differences in surface concentration of natural radionuclides, except of coastal deposits. However, Kuwait territory was heavily contaminated during the Gulf War due to large quantities of released crude oil and the atmospheric discharges from incomplete oil combustion from the burning of oil wells. Although oil and natural gas contain only trace quantities of the naturally occurring long-lived radionuclides, because of the large scale of atmospheric discharge the emitted activities were appraised as : 6.7 GBq-²³⁸U, 10 GBq-²²⁶Ra and 5 GBq-²³²Th (1). In addition, the use of uranium tipped antitank shells during the Gulf war was another source of possible uranium contamination of the surface soil of Kuwait. Therefore continuous background radionuclide concentration measurements were initiated as a part of a program for assessment of radiation doses from natural sources for Kuwait population.

METHODS

The location of the 69 sites where soil samples were taken are shown in Fig. 1. These locations are non random and are positioned in the Kuwait City, its vicinity, along major highways and in the special geological formations. The several samples were also collected from the Gulf War battle-field (Mutla area). Three samples from the uninhabited islands: Guruh, Maradin and Kubar were also analyzed. The soil samples (top 5 cm) were collected from 100 sq. cm surface- three samples from each site. All samples were dried at 110° C and 1.5 kg fraction which passed through 12 mesh sieve was placed in the plastic Marinelli beaker and stored for three weeks to allow build up of radon and its daughters. The samples were counted using high purity Ge detector and the spectra were analyzed using Sampo-90 program. The detector was calibrated by adding the mixed radionuclide standard - QCD 1 (Amersham) to soil sample followed by homogenization of sample.

Concentrations of ²³⁸U were determined directly from 92.6 keV and ⁴⁰K from 1461 keV peaks. In identifying ²²⁶Ra the five principal γ -rays were analyzed: 295, 325, 609, 1120 and 1765 keV from ²¹⁴Pb and ²¹⁴Bi radionuclides. Also for analyzing of ²³²Th five γ -lines: 239, 583, 727, 911 and 969 keV from its daughters. ²⁰⁸Tl, ²¹²Bi and ²²⁸Ac were used. Additionally the concentration of ¹³⁷Cs deposited after nuclear bomb tests were also determined.

RESULTS AND DISCUSSION

The calculated average concentrations of measured radionuclides are as follows:

²³² Th ---	10.0 \pm 3.5 Bq kg ⁻¹	ranged from 0.57 to 16.3 Bq kg ⁻¹
²³⁸ U ---	13.4 \pm 5.2 Bq kg ⁻¹	ranged from 7.0 to 30.7 Bq kg ⁻¹
²²⁶ Ra ---	11.8 \pm 4.4 Bq kg ⁻¹	ranged from 2.25 to 22.8 Bq kg ⁻¹
⁴⁰ K ---	329.3 \pm 111 Bq kg ⁻¹	ranged from 4.4 to 496.5 Bq kg ⁻¹
¹³⁷ Cs ---	2.8 \pm 2.6 Bq kg ⁻¹	ranged from 0.1 to 9.9 Bq kg ⁻¹

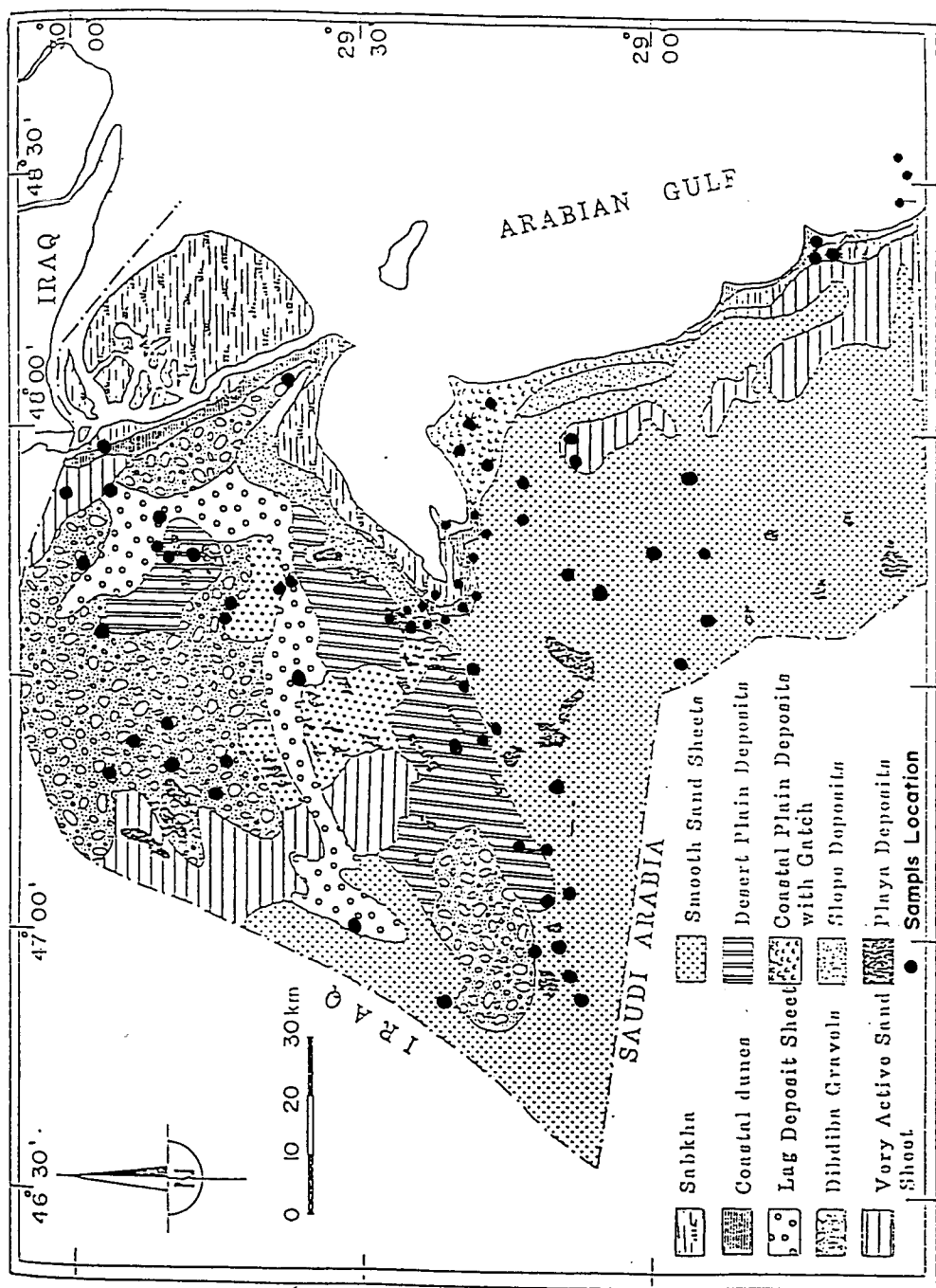


Fig.1. Surface deposit distribution in Kuwait and location of background soil samples

The highest concentrations of ^{238}U were observed in the samples from coastal area (Ras Al-Zoor) and from the island soils. The same samples showed very low ^{232}Th , ^{226}Ra , and ^{40}K values. No significant differences in uranium concentrations for Mutla area and other places have been found. The average concentration of ^{232}Th and ^{238}U in Kuwait surface soil were lower than the world average value of $40 \text{ Bq}\cdot\text{kg}^{-1}$ (2) since the large area of Kuwait is covered with desert sandy soil. In the most cases daughter radionuclides of uranium and thorium series were found in a radioactive equilibrium except of those from Ras Al-Zoor and islands-samples.

On the basis of these measurements and dose rates per unit concentration in soil, adopted from UNSCEAR (3,4) the average absorbed dose rate in air (at 1m height) from gamma field of ^{232}Th , ^{238}U series and ^{40}K radionuclide was estimated on 0.234 mGy per year for Kuwait territory.

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