بسم الله الرحمن الرحيم

# التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

# جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

## قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها

علي هذه الأفلام قد أعدت دون أية تغيرات

## يجب أن

تحفظ هذه الأفلام بعيدا عن الغبار

في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

**To be Kept away from Dust in Dry Cool place of 15-25- c and relative humidity 20-40%**

# بعض الوثائـــــق

# الاصليـــة تالفـــة

بالرسالة صفحات
لم ترد بالاصل

Faculty of Science
Physics Department

# Measurements of Radon Gas Concentrations and Radon Progeny in Uranium Exploration Galleries

BY

**Yassin Abdel-Azim Mohammed Abdel-Razek**

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Diploma in Radiation Physics (1989)

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| **Supervisors** | **Approved** |
|---|---|
| **1- Prof. Soad Abdel-Monem El-Fiki**<br>Prof. of Radiation Physics. | S. A. El Fiki |
| **2- Prof. Hoda Mohammed Eissa**<br>Prof. of Radiation Physics ,<br>Head of the Department of Radiation Measurements (NIS). | H. M. Eissa |
| **3- Prof. Abdalla Abdel-Halim Abdel-Monem**<br>Prof. of Geochemistry, ex-head of Research Sector (NMA). | A. A. Abdel-Monem |

**Head of Department**

**Prof. M. A. Khashan**

TO MOTHER.

FATHER.

BROTHER TAHA.

AND WIFE.

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# SUMMARY

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Radon gas and radon daughters are known to constitute a major health hazard in uranium exploration and mining works. Routine periodic monitoring has become an established practice in such sites in order to calculate the potential alpha energy exposures to which workers especially in underground galleries are exposed. Thus, radiation protection measures in these sites can be formulated and occupational radiation hazards can be prevented.

Many techniques and methods are in use to measure radon and radon daughters concentrations. In this study, Tsivoglou method as one of the active methods and Solid State Nuclear Track Detectors SSNTD as passive monitors were employed to achieve these measurements in three U-exploration galleries belonging to the Nuclear Materials Authority (NMA), Eastern Desert, Egypt.

Tsivoglou method is described and the four types of SSNTD namely CR-39, MK, CN-85, and LR-115 are introduced and experiments to study their characteristics are described and the results are anlyzed. Mathematical calculations are carried out to obtain the values of the equilibrium factor at each monitoring station using the results obtained by Tsivoglou method. Theses calculations are extended to develop the use of bare SSNTD in the measurements of radon and radon daughters concentrations by calculating correction factors for the alpha activities at each monitoring station corresponding to the different values of the equilibrium factor or the ratios of the individual radon daughters concentrations. Optimum etching conditions for each type of SSNTD

and the response of them to alpha energies in the range 1-5 MeV are discussed.

Radiation exposures to potential alpha energy concentrations in (WLM) are calculated to see whether or not these concentrations constitute any occupational hazards to workers in these galleries.

The average value of the equilibrium factor at the monitoring stations in the non-ventilated drifts is 0.831.

The optimum etching conditions of SSNTD used in this study were found to be, a 6.25 *N* NaOH solution at 70°C for 8 hours for CR-39, a PEW solution at 70°C for MK, and a 2.5 *N* NaOH solution at 60°C for 3 hours for both CN-85 and LR-115. CR-39 detectors have the higher response to alpha energies > 5 MeV and relative to their calibration factor to measure radon and radon daughters concentrations, the relative calibration factors of SSNTD used in this study are 1:0.64:0.55:0.31 for CR-39:MK:CN-85:LR-115 respectively.

Measurements achieved by SSNTD were found to respond well to the local controlling factors such as the shear zones , U-concentrations and ventilation while those achieved by Tsivoglou method reflects the fast variation of radon daughters concentratios in time.

Depending on the amount of internal surfaces in the rocks emanating radon which is affected by the seasonal variation of temperature, radon concentrations measured in spring are almost twice that measured in winter. Estimations of the values of the emanating coefficient of the rocks composing the work sites obtained values in the range 0.4-0.55.

Potential alpha energy exposures were found to be minimum at the ventilated stations and maximum at the non-ventilated ones and the measurements indicated the need for artificial ventilation in these sites.

## List Of Symbols

| | |
|---|---|
| $T_{1/2}$ | half-life |
| $\lambda_i$ | decay constant of element i |
| $N_i$ | Number of atoms of element i |
| $C_i$ | Activity concentration of element i |
| t | time |
| $\varepsilon_p$ | potential alpha energy of an atom |
| $c_p$ | equilibrium factor |
| $F_{eq}$ | potential $\alpha$-energy exposure |
| $P_p$ | Equilibrium equivalent exposure |
| $T^`$ | exposure time |
| $C_{eq}$ | Equilibrium equivalent concentration |
| WL | working level |
| WLM | working level month |
| e | electronic charge |
| $m_o$ | electronic mass |
| $\varepsilon_o$ | permittivity of free space |
| I | electronic mean excitation potential |
| $V_B$ | Bulk etching rate |
| $V_T$ | Track etching rate |
| d | diameteter of etch pit |
| $\delta$ | cone angle |
| h | removed layer |
| $L_e$ | length of etch pit |
| v | velocity of a particle |
| L | length of latent track |
| $\theta$ | incidnce angle |
| $\varphi$ | emanating coefficient |
| $\Psi$ | emanating power |
| F | flux of atoms |
| W | enclosing volume of the chamber |
| $D_i$ | diffusion coefficient |
| w | fracture width |
| G | grade of the rock |
| $\rho_g$ | density of the ore rock |

| | |
|---|---|
| $F_{eq}$ | equilibrium factor |
| $R_i$ | drilling room no. i. |
| $XC_i$ | cross cut no. i. |
| DI | drift no. I. |
| $\overline{X}$ | average counts per minute |
| N' | number of one-minute counts |
| $\chi^2$ | chi-sqaure |
| $\sigma$ | standard deviation |
| E | efficiency |
| $V_c$ | calculated flow rate of the air pump |
| $V_p$ | flow rate on the flow rate meter of the air pump |
| V | actual flow rate of the air pump |
| $K_p$ | calibration factor of the air pump |
| $C'_i$ | counts on filter paper |
| S | self absorption of the filter paper |
| $C_i$ | activity concentration of the element i |
| BG | background |
| $A_i$ | one-minute count at i minutes after sampling |
| R | ratio of alpha activity |
| $A_\alpha$ | total alpha activity |
| $R_{n\alpha}$ | alph activity of radon |
| $R_n$ | radon gas |
| $F_1$ | radon correction factor |
| $F_2$ | WL correction factor |
| B | $C_{RaB}$ / $C_{RaA}$ |
| Q | $C_{RaC}$ / $C_{RaB}$ |
| $\rho$ | track density per day ( tracks.mm$^{-2}$.d$^{-1}$ ) |
| $K_1$ | radon calibration factor |
| $K_2$ | WL calibration factor |