Teeth as a biomarker for pollution by Alpha particles

(Practical study)

by

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This study dealt with the subject of natural exposure to radiation, which was considered a very important topic because it was linked to human health, the rate of alpha emission from was measured using a nuclear track detector CR-39 to determine the level of environmental contamination by alpha-emitting.

Key words: Alpha, CR-39, Human teeth, Ionizing radiation, Natural radioactivity

Introduction

The amount of radiation in a natural human environment includes cosmic rays and radiation from natural radioactive elements. we exposed to ionizing radiation from natural sources at all times. This radiation called natural background radiation. All natural elements with atomic numbers $Z \geq 82$ are radioactive.

Many of researcher used teeth and other biological samples like; blood in their studies as indicator for radiation such as ; Henshew, Anees. Teeth is a good biomarkers for exposure to radiation as showed in many previous studies .

Alpha Radiation

- There are many unstable nuclei which undergo transformations accompanied by emission of energetic that called parent atom, alpha particle ($^4_2\mathrm{He}$), can be emitted from parent atom and product nucleus which contains less than parent in two protons and two neutrons [1] , as shown in **Fig.1** . Alpha particles are a one type of ionizing radiation, which is the least penetrating of the radiations emitted from unstable heavy metal [2]. These particles are harmful to living tissues than other types of ionizing radiation because of the more massive and highly charged for these particles [3]

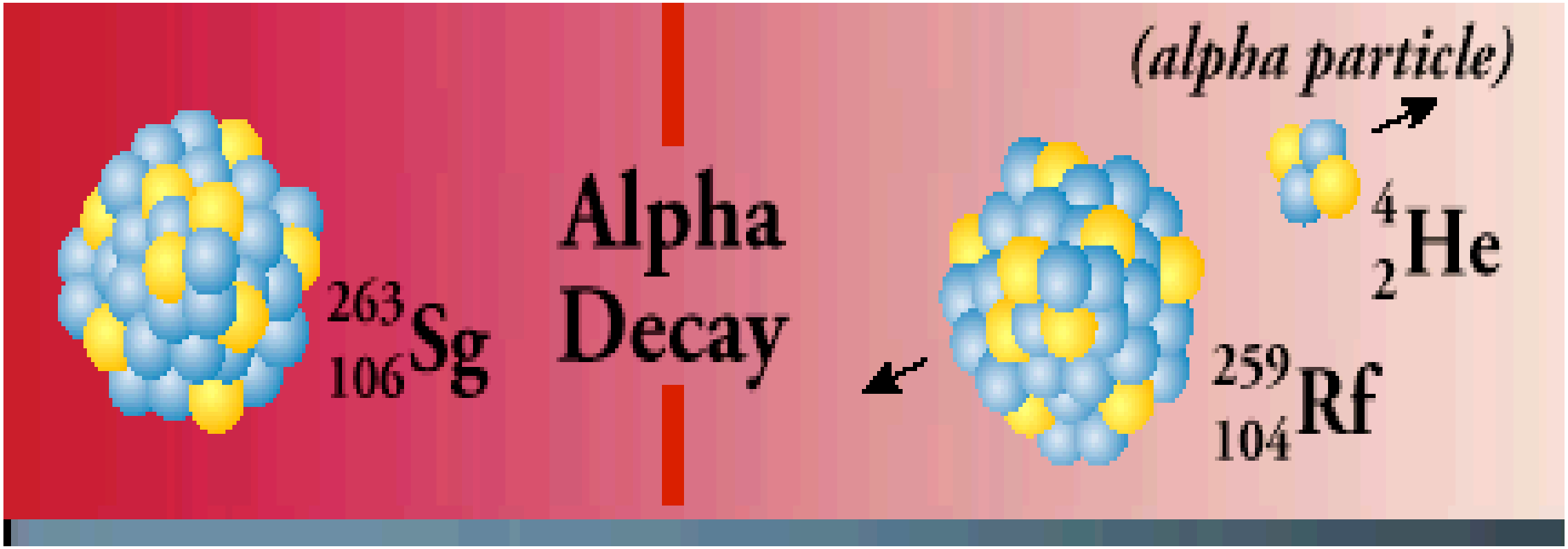


Fig.1 Alpha Radiation

Internal Exposure to Alpha Radiation

Alpha-emitters as U, Pu, and Ra enter the bodies through the digestive and respiratory system by the nourishment that we eat, or the water we drink or the air we inhale and furthermore by ingestion. When we inhale the tidy of the α-radiation emitters , these radioisotopes chemically and physiologically behave like calcium, some of it is breathed out and some stay in our lungs and then to the bone marrow through the blood.

Expermiental part

CR-39 detector

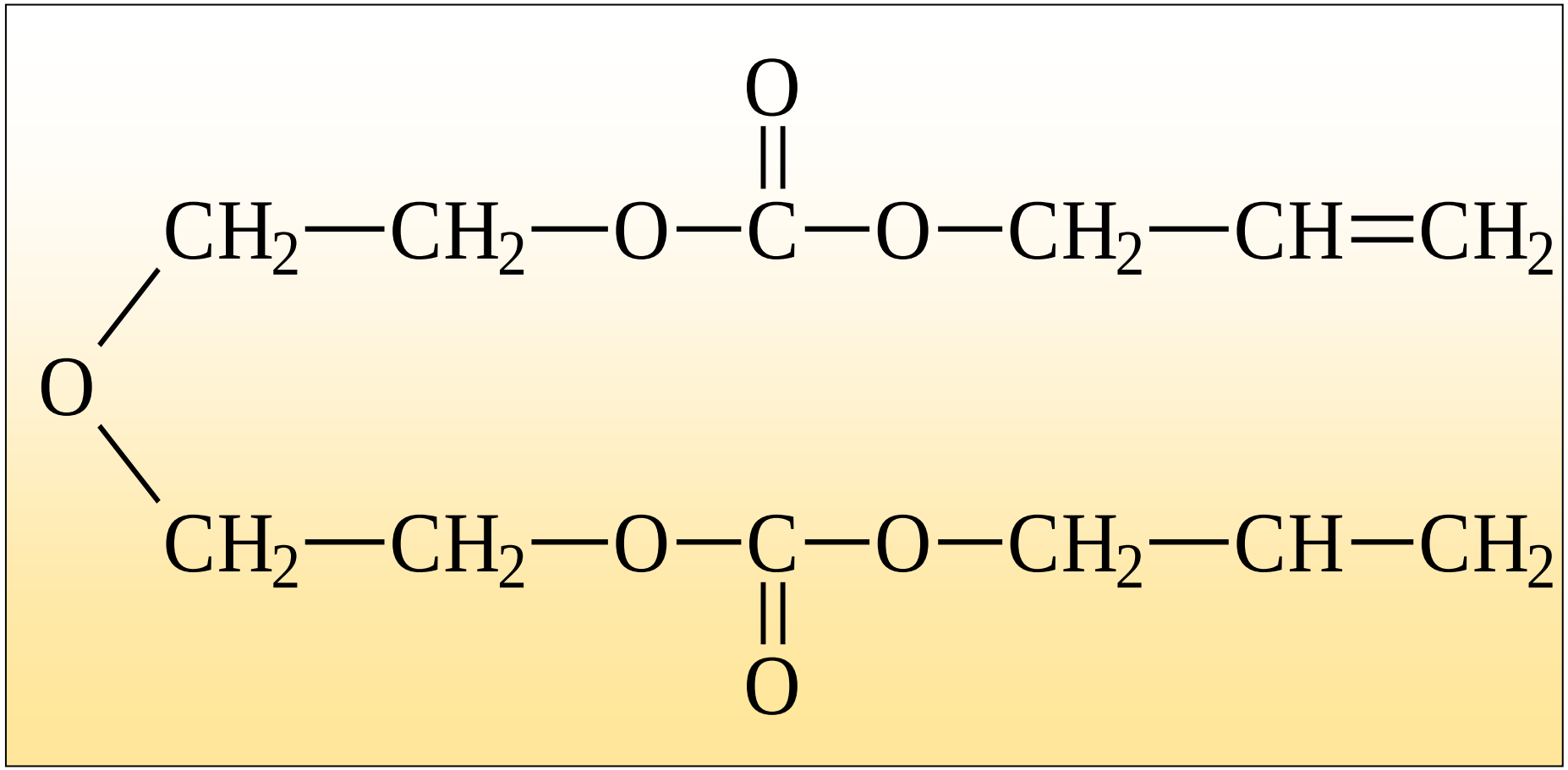


Fig.3 Chemical composition for CR-39 $C_{12}H_{18}O_7$

Nuclear Track Detector CR-39

CR-39 detector was discovered in (1978) by (Cartwright & Shirk) at the University of California, USA. It is one of the organic detectors made by polymerization of the liquid monomer, the molecular formula for CR-39 is ($C_{12}H_{18}O_7$) , has a density ($1.3\ gm.cm^{-3}$) and is insoluble in chemical solution. This detector is used in wide range applications in the nuclear impact detectors because of the high sensitivity[13].

Samples collected from different people in quantities sufficient for the purpose of the research, collection of samples from several areas within the study area. Samples were taken from people with age ranging from 20 to 65 years, including males and females with details such as; age, gender, site and smoking.

The samples studied included; 20 teeth samples.

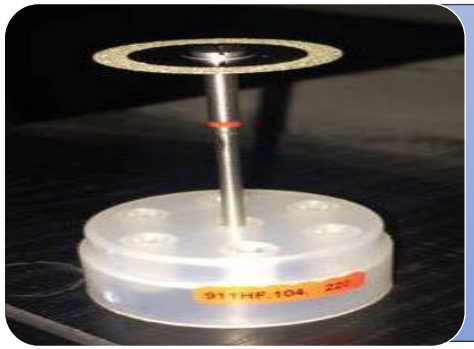
Datawere taken on each sample such as; location, age, gender and smoking as in fig.4

Sample code	Residence	Age (year)	Gender	Smoking
CR-324	AL-Jadeda	20	Male	Smoker
CR-403	AL-Jadeda	50	Female	Non-smoker
CR-353	AL-Jadeda	20	Male	Non-smoker
CR-404	AL-Jadeda	40	Female	Non-smoker
CR-300	AL-Jadeda	40	Female	Non-smoker
CR-351	Hey Al-Ameen	50	Female	Non-smoker
CR-326	Hey Al-Ameen	40	Female	Non-smoker
CR-401	Hey Al-Ameen	21	Female	Non-smoker
CR-380	Al-takya	50	Male	Smoker
CR-352	Al-takya	42	Male	Smoker
CR-377	Al-takya	46	Male	Smoker
CR-327	Abo-Saida	29	Female	Non-smoker
CR-428	Abo-Saida	40	Male	Smoker
CR-406	Moasker Khalid	35	Male	Smoker
CR-379	Al-Tahrer	42	Male	Smoker
CR-405	Qaryat AL-sada	45	Male	Smoker
CR-376	Qaryat AL-sada	50	Female	Non-smoker
CR-375	AL-Sarai	25	Male	Non-smoker
CR-325	AL-Sarai	39	Male	Smoker
CR-350	Al-Shafta	22	Female	Non-smoker

fig.4 Data About The Patient

Preparation of teeth samples

Teeth were cut longitudinally into two halves



By using the marathon micro engine device is the type of (Italy) with disk diamonds is the type of (Germany) has diameter 2 mm

The samples dried in an oven at (100^{o}C) for 2 hours . the dried samples were weighted by using digital sensitive balance. Now, the samples are ready for natural exposure method. Figure (3-3) shows the steps for the teeth sample preparation.

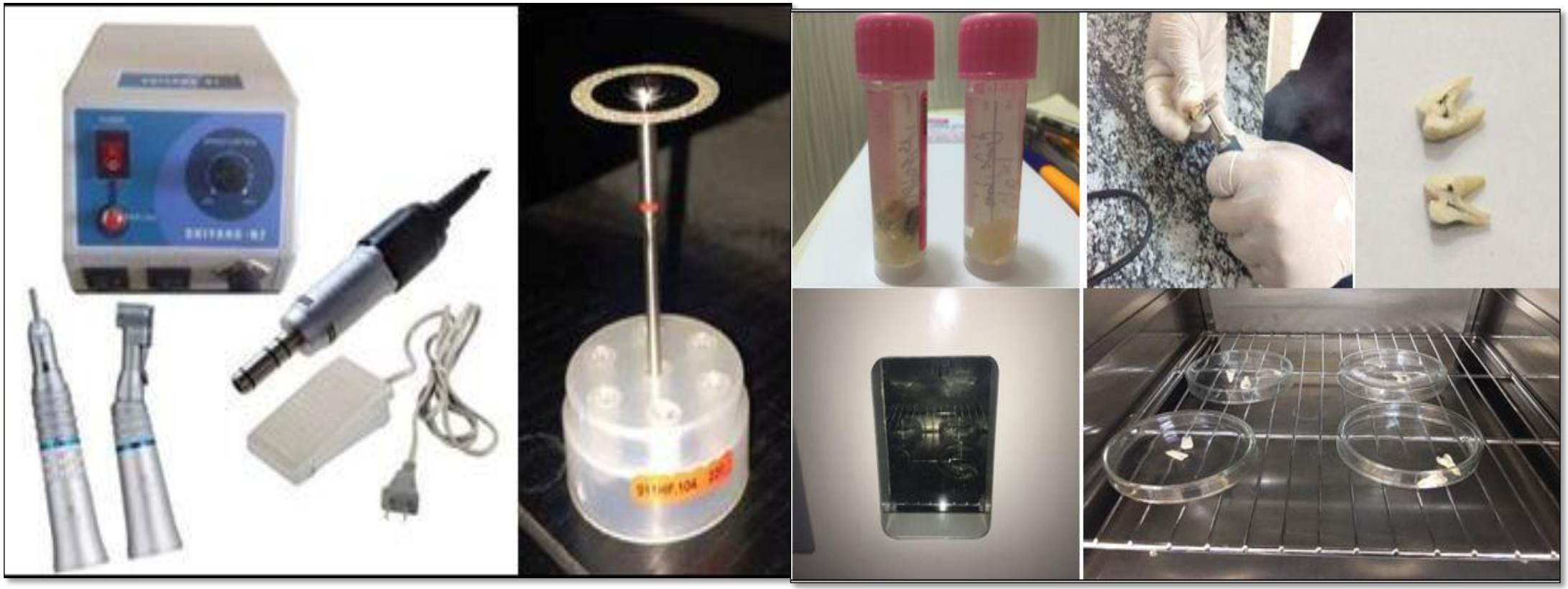


Fig.5 Preparation of teeth samples

Natural Exposure For Detector From Samples

This method includes exposing the detector to the samples directly for certain periods. All detectors were stored after attaching it with a sample, then wrapping them with tape and placing them in a plastic bag that was emptied from the air. Detectors were put in a freezer at a temperature (-18^{o} C), the exposure time was about 115 day. The detector would be ready for the chemical etching after finishing the exposure period.

Chemical Etching

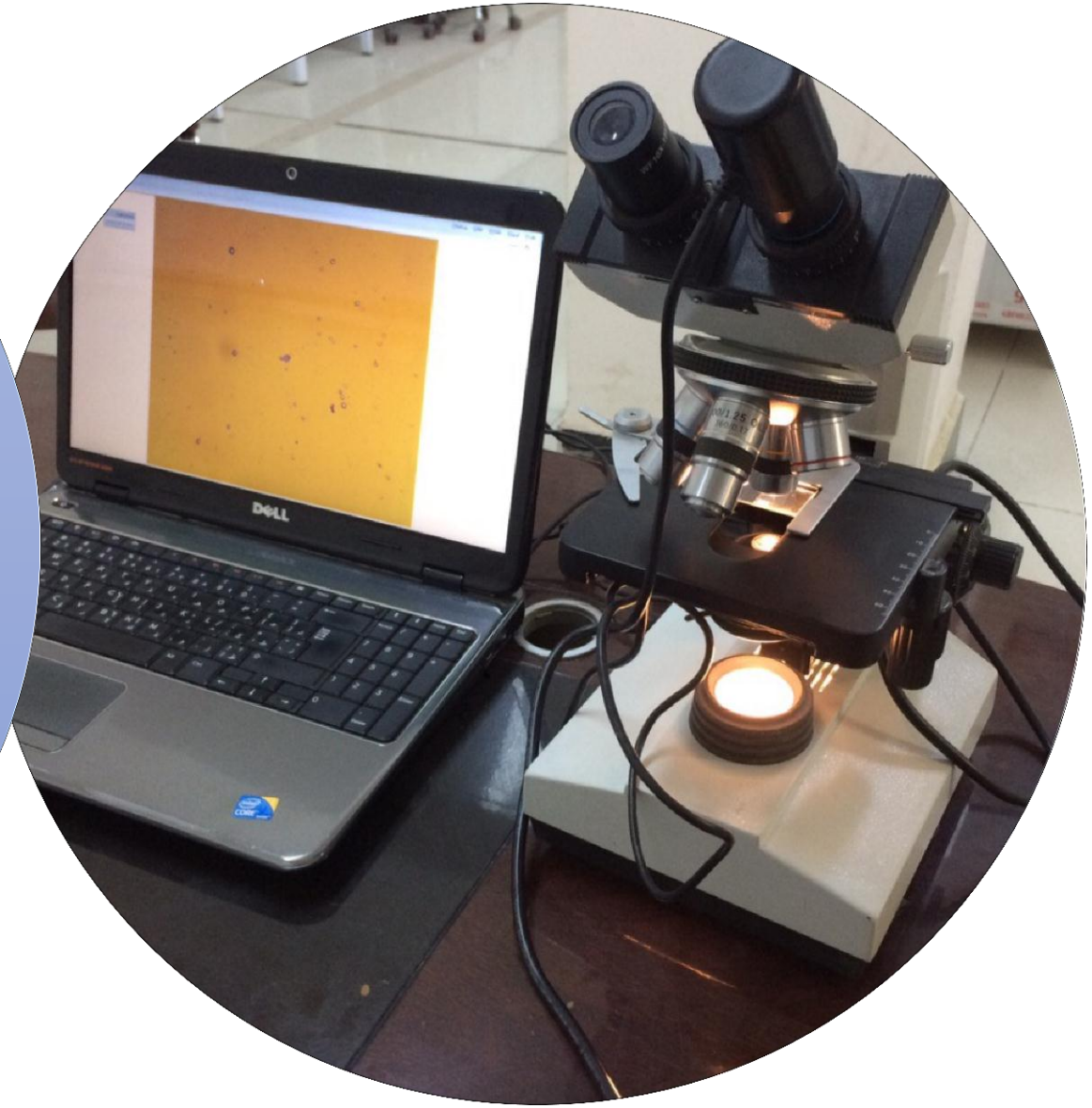
During the natural exposure period α-particle enters the TASTRAK plastic track detector; it creates a trail of damage along its path. This damage is invisible, but may be revealed by chemical etching.

The detector is immersed in 6.25 N NaOH at 75°C for a period of 6 hours. Which is prepared by dissolving (62.5) gm of (NaOH) in (250 ml) distilled water .

Chemical Etching

The solution was heated by a water bath, with the sealing of the conical flask firmly to prevent evaporation of the solution and change its concentration

View The Tracks Under The Microscope



View The Tracks Under The Microscope

- A camera was connected to a microscope to capture the tracks and connected to the laptop to show the image of the tracks on the computer screen

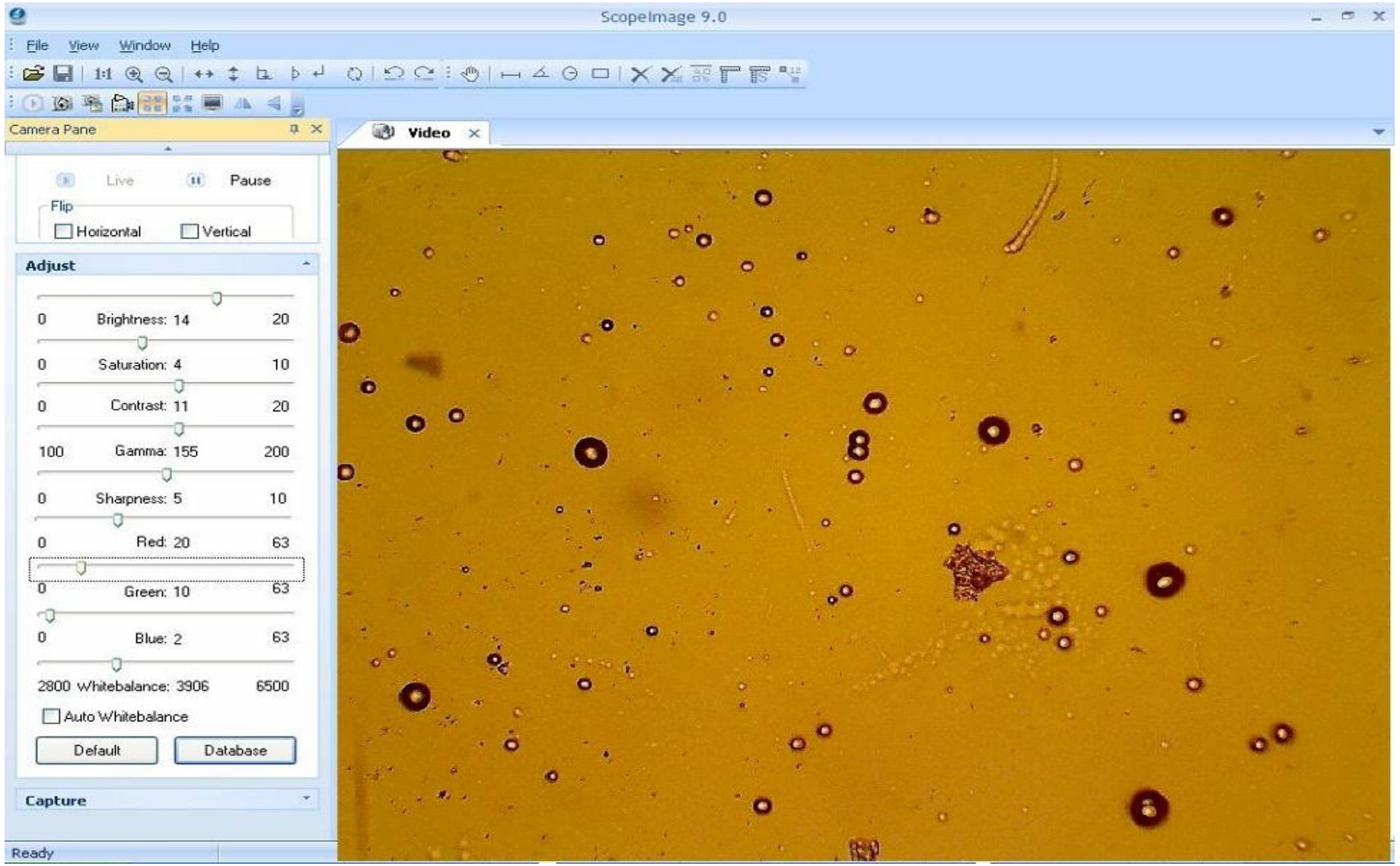


Fig.7 Main Window Scope Image Software

Calculations

Density of tracks

$$\rho = \frac{N_{avg}}{A}$$

The CR-39 Efficiency

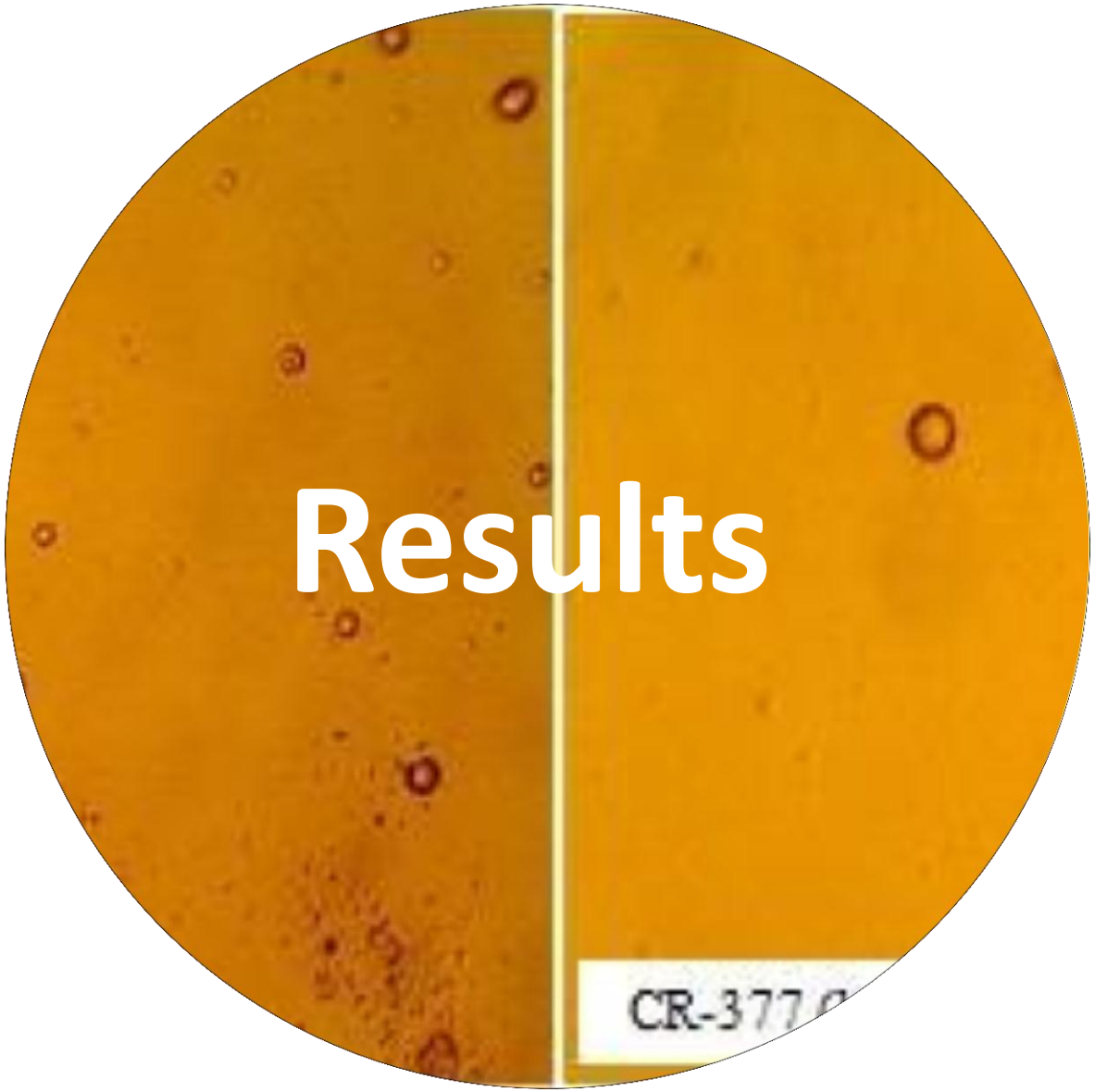
$$\varepsilon = 1 - \frac{V_B}{V_T}$$

Alpha Emission Rate

$$E\alpha = \frac{\varepsilon\,(\rho s - \rho b)}{T}$$

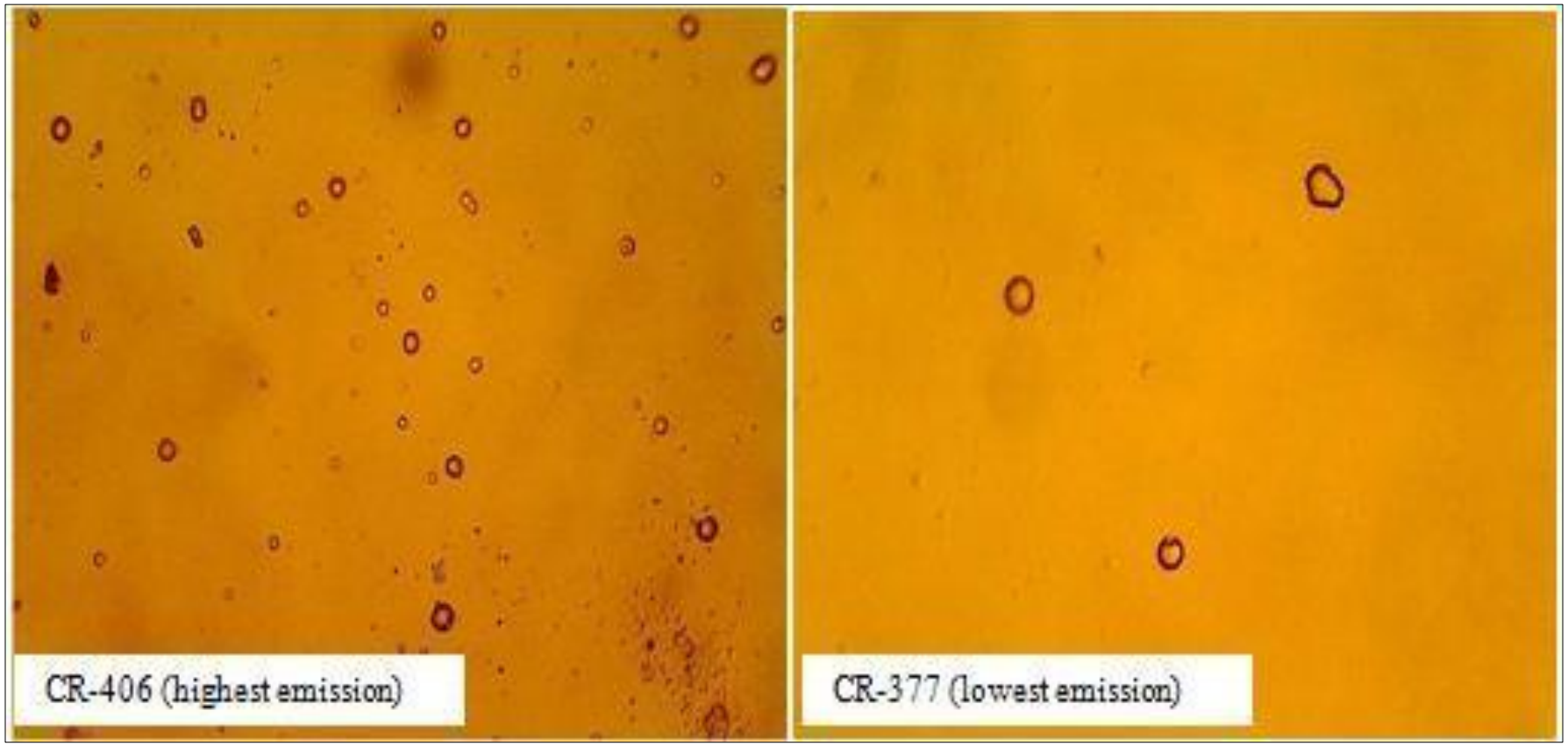
Calculations

- Where ; ρ: Alpha-Track density in unit (track cm^{-2})
- : Average number of total tracks
- A: Number of fields of view
- V_B = Bulk etch rate (µm h^{-1})
- V_T = Track etch rate (µm h^{-1})
- E_α: The alpha emission rate in unit (Bq Cm^{-2})
- Ɛ: The CR-39 efficiency
- ρ_s: Alpha track density by the teeth and blood samples (track cm^{-2})
- ρ_b: Number of background tracks in the detector (track cm^{-2})
- T: Exposure time (days)

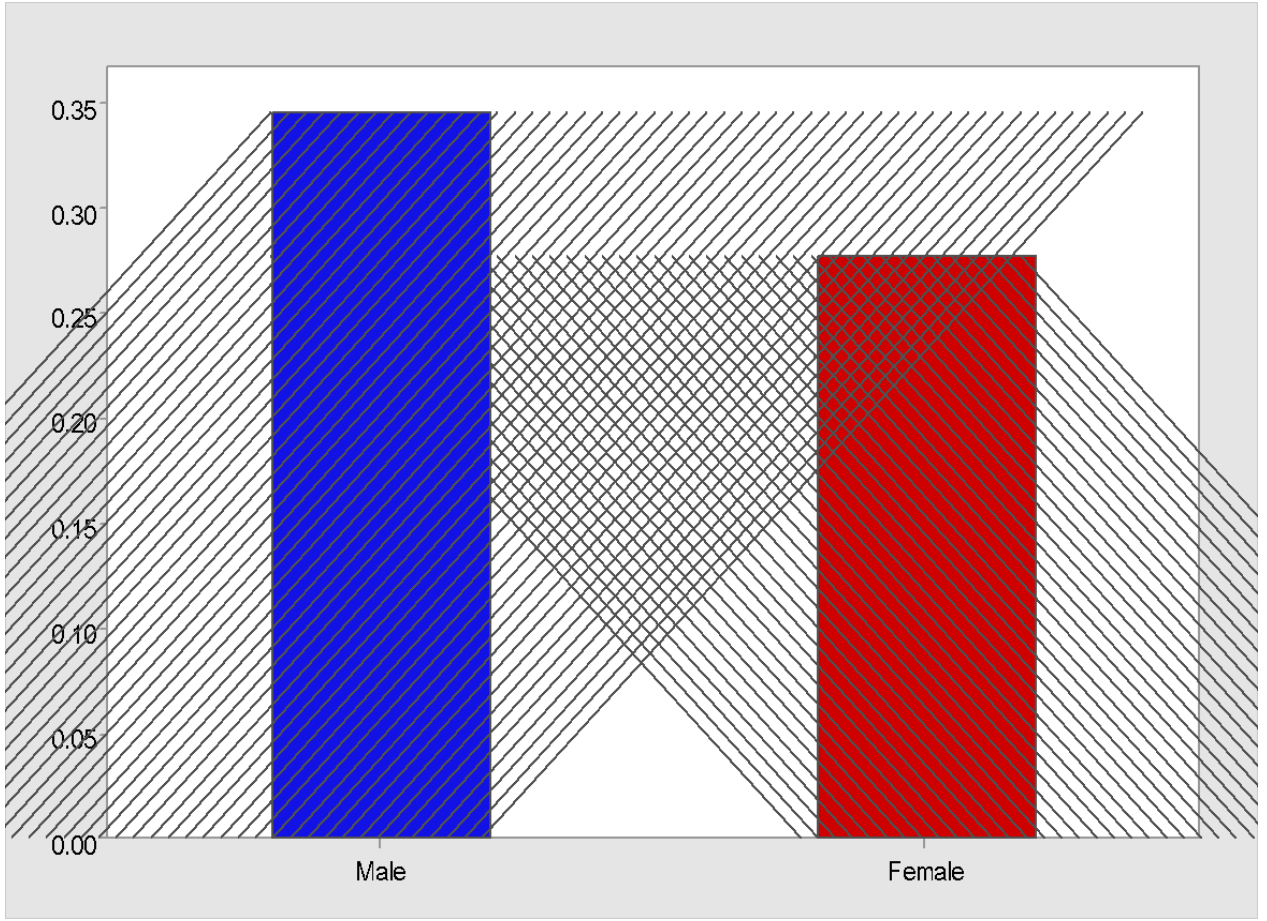

Results

Sample code	Track density(1f)	Track density(2f)	Track density/(track cm^{-2} d^{-1}) Avg.	Eα/(mBq cm^{-2})
CR-324	3.677493361	3.193129	3.4353113	0.0338
CR-403	1.299460139	1.272431	1.285945515	0.0127
CR-353	3.049874227	3.087175	3.068524408	0.0302
CR-404	3.266108209	3.354224	3.310165883	0.0326
CR-300	3.144799934	3.28913611	3.216968026	0.0316
CR-351	4.946786838	4.60784	4.777313454	0.0470
CR-326	2.507126931	2.6611936	2.584160287	0.0254
CR-401	1.761119691	2.536319	2.148719105	0.0211
CR-380	5.96741124	4.530536	5.248973828	0.0516
CR-352	1.216210055	2.331977	1.77409373	0.0175
CR-377	0.819420697	0.26856462	0.543992662	0.0054
CR-327	1.801122978	1.962217	1.881670136	0.0185
CR-428	2.57794356	2.39414467	2.486044117	0.0245
CR-406	8.99825384	8.770127	8.884190414	0.0874
CR-379	2.782284673	2.798502	2.790393448	0.0275
CR-405	2.748768406	2.743363	2.5735621	0.0253
CR-376	4.200779598	3.439636	3.820207789	0.0376
CR-375	3.02662907	3.197454	3.112041497	0.0306
CR-325	1.596781864	0.886453	1.241617548	0.0122
CR-350	5.604138145	4.690009	5.147073564	0.0506

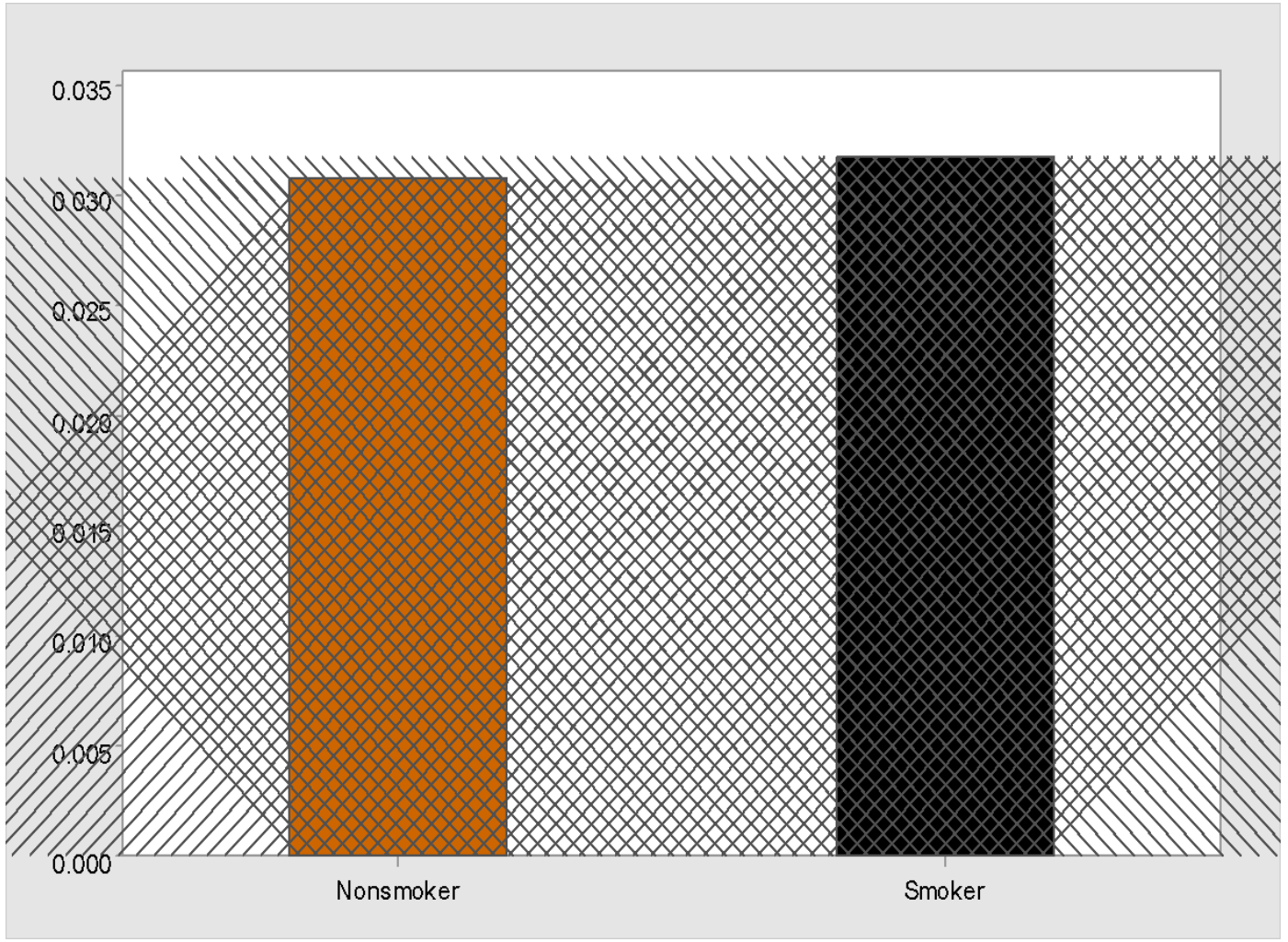
fig.8 Values Of Alpha Emission Rate For Each Teeth



Highest and Lowest Of Alpha Emission fig.9



Alpha Emission Rate Basic On Gender fig.10



Alpha Emission Rate Basic On Smoking fig.11

Conclusions

Conclusions

This study discussed alpha emission rate in human teeth from different samples in gender, age and smoking, by using natural exposure radiation method with CR-39 detector. The results and comparisons indicate that the emission rate of alpha particles does not depend on the variables on which this study was based. The data shows that Alpha Emission Rate in Diyala Governorate was 0.0312± 0.0040 mBq cm^{-2} which was within the limits allowed globally compared to previous studies, also this study showed the efficiency of nuclear impact detector CR- 39 in the counting of alpha particles, the nuclear impact detector CR-39 of good techniques suitable for the study of radioactivity as they are easy to use and do not need a complex electronic system. It is worth noting that:

- There is no correlation between alpha emission rate and location, Age, Gender and Smoking.
- All results indicate that no environmental contamination by radionuclide's that alpha emitting compared with the previous studies.

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