Measuring the Rates of Radioactive Contamination and Radiation Doses for Rockwool plant

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Abstract

This research aims to assess the radioactivity for the rock wool plant in the province of Baghdad – Al Taji city through conducting radiological survey for the plant which of six part (crushers , furnaces , machines spinning , materials store and waste site) in addition assessment of radiation doses to the worker who are near smelting furnaces by using portable detectors to know the level of exposure and the contamination resulting from smelting basalt stone operations which the essential material for making the rock wool, its contain the natural radioactivity series such as U-238 and Th-232 . The results of radiological survey were conducted showed the presence of a significant increase in the rates of radioactive contamination and the dose rates in the area of smelting furnaces ranged between (11.2- 7.81) cps using the FH-40 compared with the rate of natural background 0.75 cps and the rates of radiation doses ranged between (0.65- 0.47) µSv/h using the device RadEye compared with natural background 0.04 µSv/h ,while the reading in another site within normal levels . it also collected soil samples from the smelting furnaces and from basalt stone accumulation site accordance to IAEA standard which were measured by using gamma spectrometry (which consist of high –purity germanium detector with efficiency of 30% and resolution 2 keV for energy 1.33 MeV of ^{60}Co) . The results of laboratory tests for the soil elected showed absence of a significant increase in the values of the concentration for the radionuclide which back to the series of U-238 and Th-23 and showed a natural concentrations for isotope of Radium -226 especially in the samples that have been taken from the smelting furnaces (B1,B2) ranged between (62.23 – 24.1) Bq / kg, respectively, that Ra-226 isotope (1600 year half life) emitting Alpha and Gamma rays and decaying to the Radon gas.Where high concentrations of Radon gas is one of the main reasons causing lung cancer, so it is necessary to use protective equipment needed by workers in these factories.

Keywords: Basalt stone, Rockwool, Radiological survey, Radiation dose rates

قياس معدلات التلوث الإشعاعي والإشعاع جرعات لمصنع الصوف الصخري

أحمد عبد الحسن حسين

الخلاصة :

يهدف هذا البحث الى تقييم النشاط الاشعاعي لمعمل الصوف الصخري الواقع في محافظة بغداد / التاجي من خلال اجراء مسح اشعاعي للمعمل والمتكون من ستةاجزاء (الكسارات ، الافران ، ماكنات الغزل ، المخازن، موقع النفايات وموقع تجميع حجر البازلت) بالاضافة الى تقييم الجرعات الاشعاعية للعاملين باستخدام اجهزة الكشف الاشعاعي المحمولة لغرض معرفة الزيادة الحاصلة في مستويات التعرض والتلوث الاشعاعي الناتجة من عمليات صهر حجر البازلت الذي يعتبر المادة الاساس في صناعة الصوف الصخري وذلك لاحتوائه على السلاسل الاشعاعية الطبيعية مثل سلسلة اليورانيوم–238 والثوريوم–232. وقد اضهرت نتائج المسوحات الاشعاعية التي اجريت وجود زيادة ملحوضة في معدلات التلوث الاشعاعي في منطقة افران الصهر تراوحت بين 11.2(cps– 7.81) باستخدام جهاز FH–40مقارنةً مع معدل الخلفية الاشعاعية الطبيعيةcps 0.75 اما معدلات الجرع الاشعاعية تراوحت بين µSv/h(0.65–0.47) باستخدام جهاز RadEye مقارنةً مع الخلفية الطبيعية µSv/h 0.04 اما بقية المواقع فكانت القراءات ضمن مستوياتها الطبيعية . كما واخذت نماذج تربة من افران الصهر ومن موقع تجميع حجر البازلت وفق المعايير والمواصفات المعتمدة عالميا لهذا النوع من قياسات النشاط الاشعاعي. وتم قياساها باستخدام منظومة الجرمانيوم عالي النقاوة ذو كفاءة 30% وقدرة فصلkeV 2 للطاقة MeV 1.33 لنظير الكوبلت ^{60}Co ، اظهرت نتائج الفحوصات المختبرية لنماذج التربة الماخوذة عدم وجود زيادة ملحوظة في قيم النشاط الاشعاعي النوعي للنويدات المشعة التي تعود الى سلسلتي اليورانيوم–238 والثوريوم–232 واظهرت تراكيز طبيعية لنظير الراديوم –226 خاصةً في النماذج التي تم اخذها من افران الصهر حيث تراوحت بين Bq/kg (62.23–24.1) حيث يعتبر نظير الراديوم–226(ذو عمر نصف 1600 سنة) من النظائر الباعثة لاشعة الفا وكاما ويتحلل الى غاز الرادون, وحيث ان ارتفاع تراكيز غاز الرادون هو احد الاسباب الرئيسية المسببة لسرطان الرئة لذا فانه من الضروري استخدام المعدات الوقائية اللآزمة من قبل العاملين في هذه المصانع .

الكلمات المفتاحية : حجر البازلت ، الصوف الصخري ، معدلات الجرعة الاشعاعية

Introduction

Exposed human Since ancient time tonaturalradiationoriginating fromcosmic raysandotherradioactive material werefound inthe Earth's crustsince its creation Asconsisting ofradionuclideactiveradiationgenerated bythe dissolution alpha particles, beta and gamma andcan enterthese particlesintothe human bodythrough foodorbreathing and the main importantsources of natural exposurearepotassium-40,carbon-14and three important natural chainsareUranium-238, Thorium-232andActinium-235 [1] .

Representedradioactivityin sometypes ofrocksradionuclideoriginGround (primordial radionuclide) Such as potassium-40as well as theradioactive elementsof thechainsof Uranium-238and Thorium-232 However therate ofradioactivityresultingfromthe concentration ofthese elementsvary from onetypeto anotheraccording to thesenaturalrocks[2] examples ofthese typesarebasalt rocks which is igneous rocksvolcanicblackcolorcontaining52% ofsilica(SiO2)interferenceina multitude of uses, including pavingroadsrailways, in theornamental stones, shieldsconcrete,pipecorrosion resistance andin the manufacture ofrock wool Material [3].

Rock wool Materialisa natural substancein the form ofinorganicfibersassembled due tothe exposure ofmoltenbasalt rocksof thefast-movingcylinders characterizedby isolatingheat, sound, and highresistancetofire it is also usedin thelining ofthe vessels air conditioning systems from the insideorfrom the outside. In Iraqthere isone factoryto produce thisMaterialwhich is**THAT AL-SAWARI**plant located in theTaji area/province of Baghdad. [4]

2- Description ofthe plant:

The plant is located in the north-western province of Baghdad/Taji area It is one of the subsidiaries the Ministry of Industry and Minerals It consists offourmain parts, a crushers, smelting furnaces, spinningmachinesand stores. Themanufacturing processes ofmaterialpassfourstages the first phaseiscrushingbasaltstone into small piecesbycrushers steel giant, The second phase is passed small pieces of basaltstonesin to special furnaces which are in fact only two furnace ,the temperature rangefor each furnace between (1250 °C - 1110°C)degreesCelsius , The third stagethenturnstomoltenbasalt stonewithvery high heatandpour into Fast-movingcylindersin order tobecome in the formofcysticconfluentRockwool Material , The fourth stage is passed to the spinning machines and rolling with aluminum platesin order to beready for use.

3-Materials andmethods

Setthe backgroundradiation:

Foridentifyingthe backgroundradiationof the plantwere measuredrates ofexposure andradioactive contaminationofareasnear the plantusing aportableradiationdetectors , 50readinghave been recordedof the siterepresentsthe rate ofexposure andcontaminationat the site . soilsamples were elected from the site ofassemblybasalt stoneandsmelting furnacesto conductlaboratory analyzesand knowledge ofthe concentration of theradionuclide.

Radiologicalsurveys:

Conducted radiological surveysfor the plantusingportable devicesanddepending on theinstructions issued by theInternational Atomic Energy Agency(IAEA)[5] were dividedmeasurement areainto

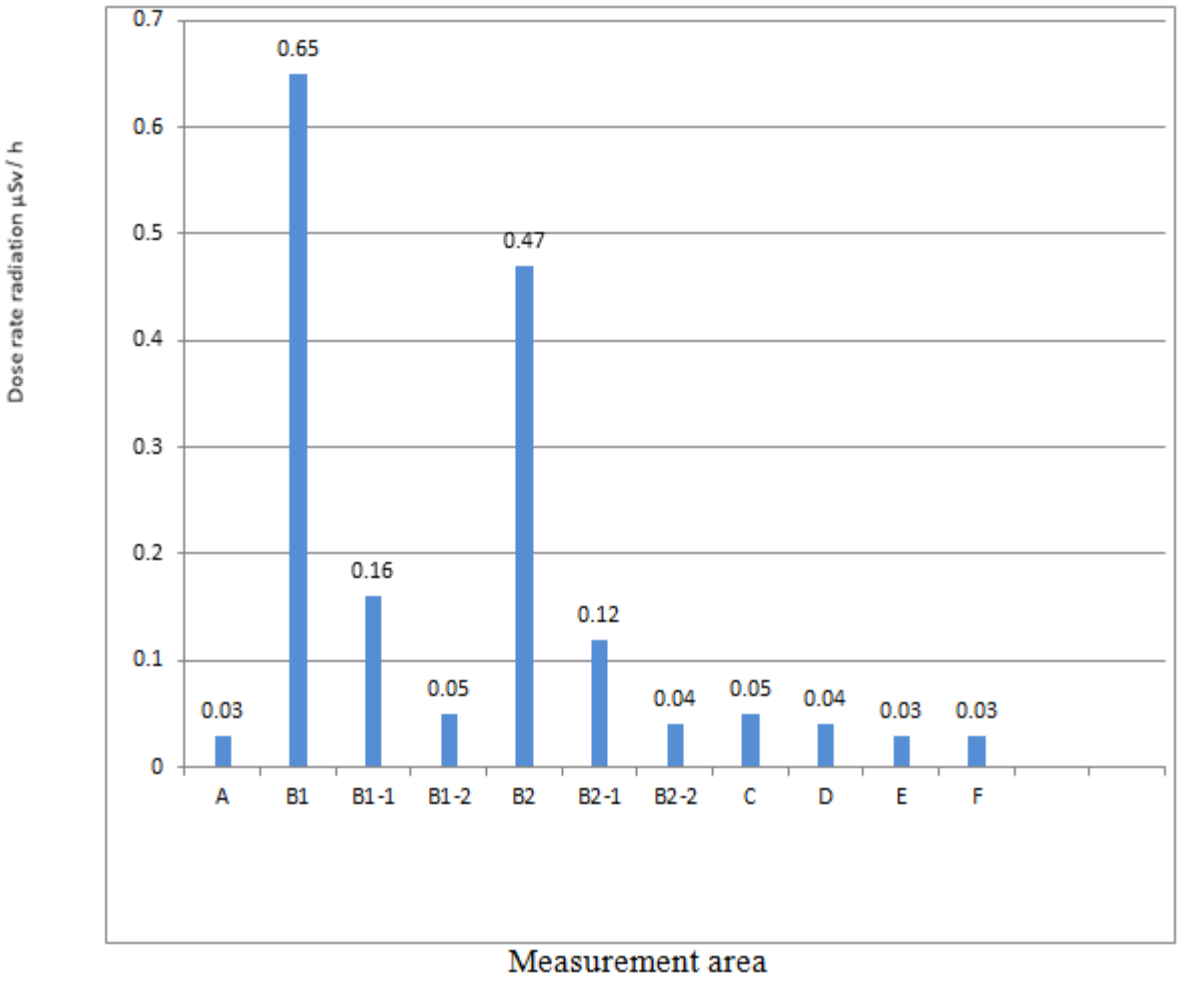
squaresaccording to natural andsize of the areawhere they weredivisionthe plantintosixregions crushers area (A),smelting furnaces(B),machinesspinning(C),storeraw materials,(D),wasterock wool(E),siteassemblybasalt(F)and the fact thatsitefurnacesare the more important of therest sitesthereforeconductedmeasurementsof radiationfrom the front of slot first furnace, and at a distance 1 meterand 2meters (B1, B1-1, B1-2), respectively, and in the samewayfor the second furnace(B2, B2-1 , B2-2).the rates ofradiation exposure weremeasuredat an altitude of1 meterfrom thesurface of the earththroughwalkingslowlyon footwhile the measurements ofradioactive contaminationratesat an altitude of5 cm from thesurface of the earth .

4– Thedevices used:

Rad Eye PRD device : A portable deviceto measure thedoseof radiation which is a sodium iodidedetectorwithhigh sensitivityfor the detection ofthe source ofionizing radiationwiththe low level through dose rateradiation thatresulting from exposuretogamma rays , provideropticalamplifierallowsfor the detection oflow-levelsof radiation, Contains anLCD displaythat showsthe results,andweight160grams, size96mm x61mm x31mm,the possibility ofdetectingenergiesrangingfrom(60keV - 1.3MeV),consumeslittle power(battery number2voltage1.5 V),theunit of measurement µSv/ h[6].

FH-40 G-L10 device : Is aportable devicewith adigital scalewiththe detector byconnectingan externalcableto detectcontaminationAlpha, BetaandGamma rays unitscps / h.Thisdeviceis one of thetypes ofcountersproportionalityprovidertubeproportional counterinternal, has aLCD screenthat showsthe results,weight410grams, size195mm x 73 mm x 42mmx,can be separatedthe detectorcontaminationfrom the deviceso that it becomesa device for measuringthe rateof radiation dosesthe extent ofenergiesranging from(33 keV-3MeV)andunits ofµSv /h,consumeslittle power(battery number2voltage1.5 V) [7].

Gamma spectroscopy system has used to measure the concentration of radionuclide in the soil models , which consistsof the counter germanium high-purity with the efficiency of30%and the amount of resolution 2keV ,Energy1.33MeV for cobalt-60 isotopeand thedetectoris surrounded bya protective barrierhighefficiencymade by Canberra company U.S. the program uses analytical gamma vision6.8developed, were calibrated energy and efficiency measurement system using a standard source multi-energies (MGS5.1045)withradioactivity1.1 Ciµ the radioactivity of soil samplesis measured of after transfer the contentstoa special containercalled (Marnelli Beaker)3600 seconds was chosen astimeto measure themodels[8].



figure(1)the results ofmeasurementsof radiationdoseratesforelectedpositionsat the plantbyRadEye device

Radiologicalsurveyswere conductedto measure therates ofradioactive contaminationofsiteselectedin the plant byFH-40 devicea unit of measurement cps and the resultsare shown infigure(2)

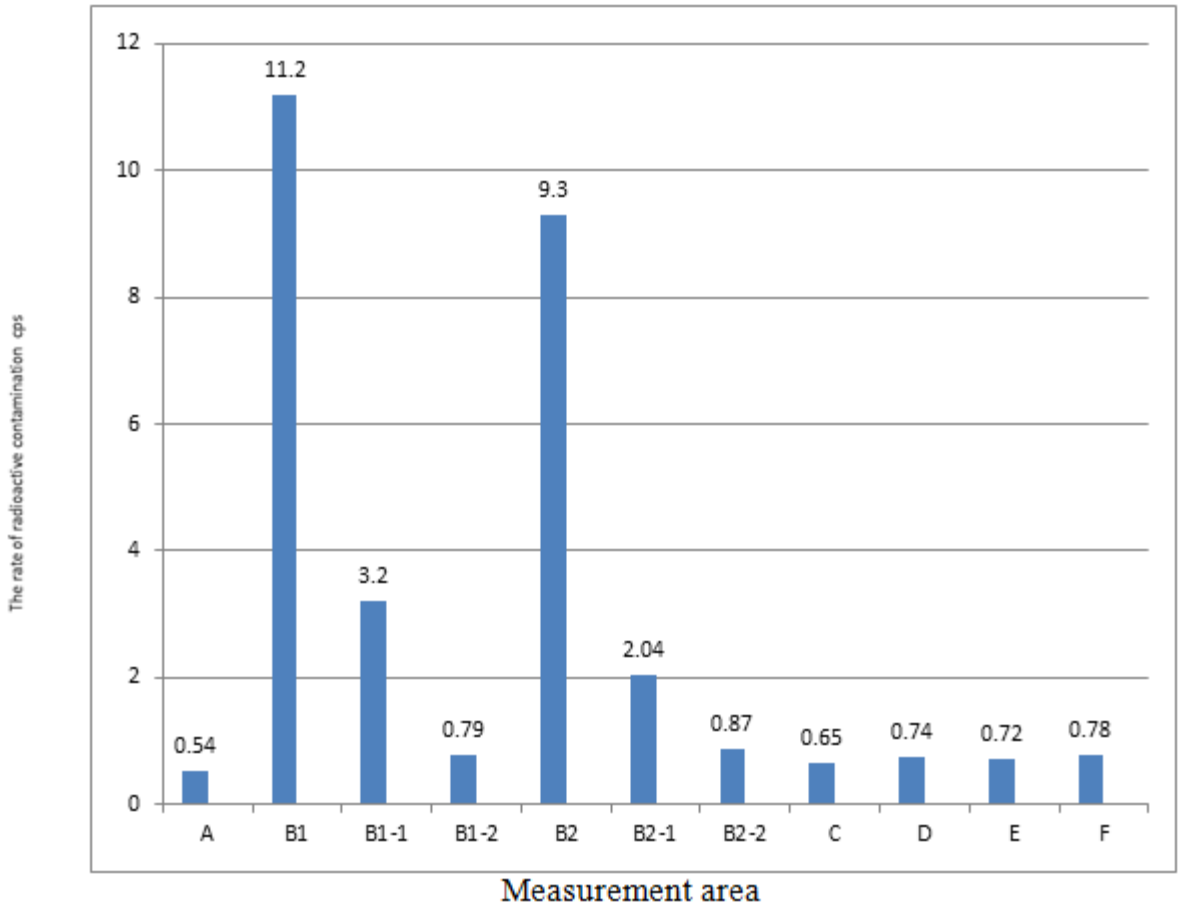


Figure (2)the results ofmeasurements ofradioactive contaminationratesforelectedpositionsat the plantbyFH-40 device

Figures(1,2) show of measurementsusing aportableradiationdetectiondevices, which referring to the lack ofa significant increasein the rates ofradiationdosesandradioactive contamination that can beexposed toa person whoexist inthose areas exception thefurnaceswhererates of radiation dosereached at the site ofthe firstfurnace (B1) 0.65 µSv/h andradioactive contamination 11.2 cps , at the second furnace (B2) the rates of radiation doses values reached 0.47 µSv/h andradioactive contamination 7.81 cps all of thesevaluesare higher thantwice thenaturalbackgroundradiation, which is 0.04 µSv/hfor therates of radiation doses and0.75 cps for therates of radioactive contamination . Thusthe workerswho are inthat locationshould applythe instructionsof the InternationalAtomic Energy Agencywith regard tothe principles ofradiation protectionto makeexposureswithinprescribed limitslaid downglobally[9].

To give thereliabilityand characterization ofcomprehensive for the radiological surveysand the radioactivityofsiteselectedweretakingsamplesof soilfrom thesmelting furnaces which areonly two furnaces(B1, B2)andsite of assemblybasalt(F1, F2, F3)these samplesmeasured by using thesystemanalysis of thespectra ofgamma raysand theresults of the analysislaboratorymodelselectedshapesare shown in(3,4,5,6) .

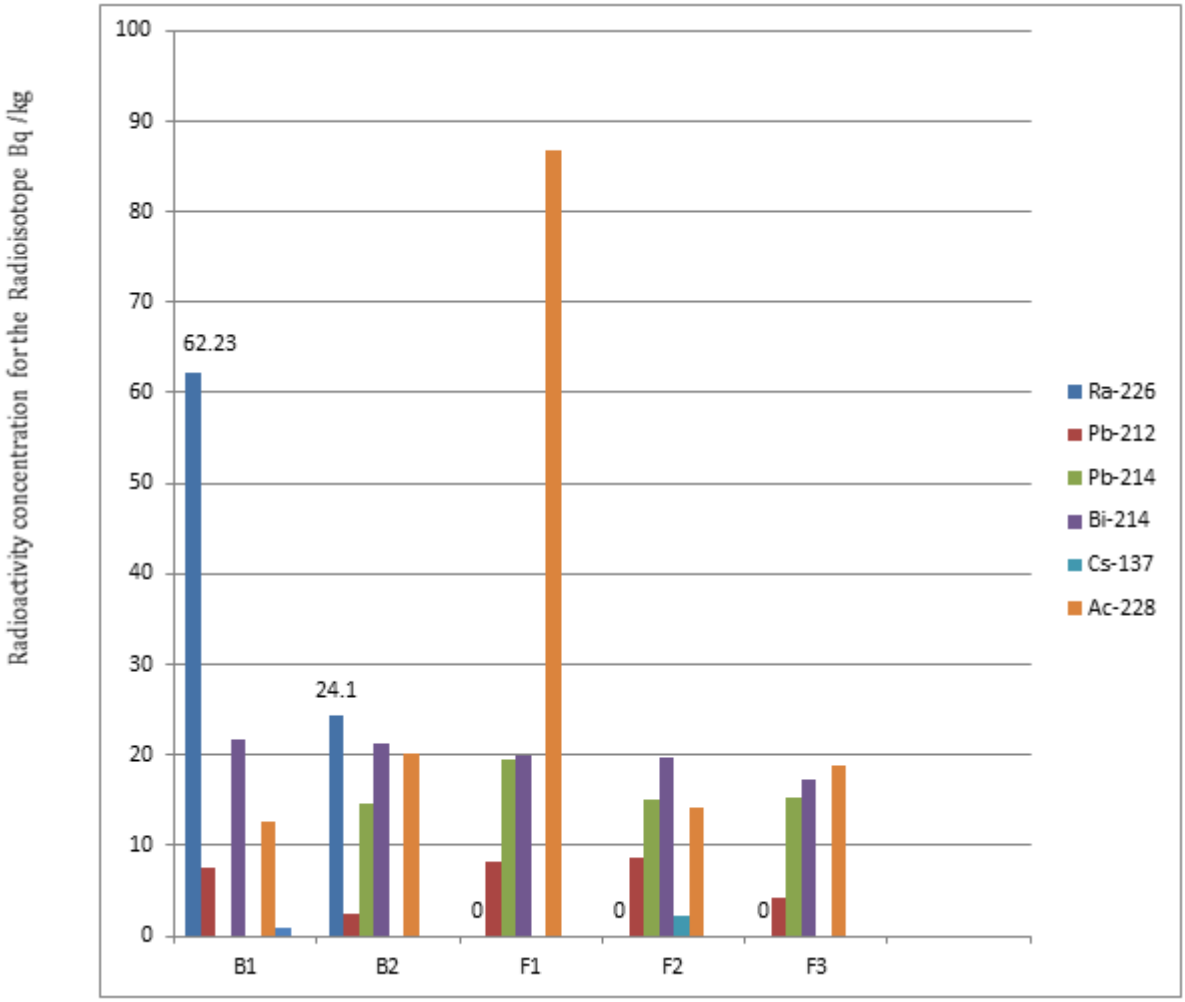


Figure (3)Radioactivity levels for theRadioisotopeinsoilsampleselected

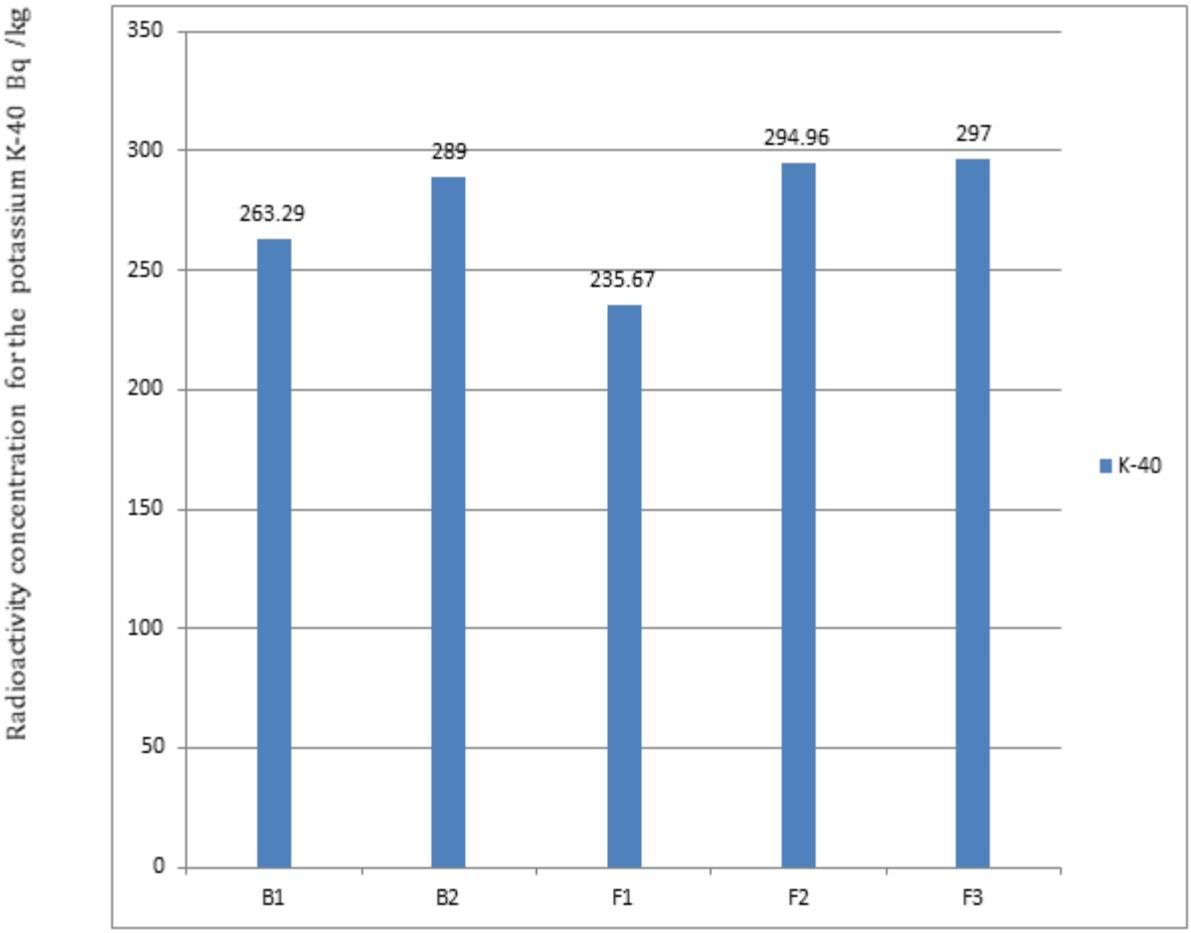


Figure (4) radioactivity levels forisotopepotassium- 40in thesoil samples elected

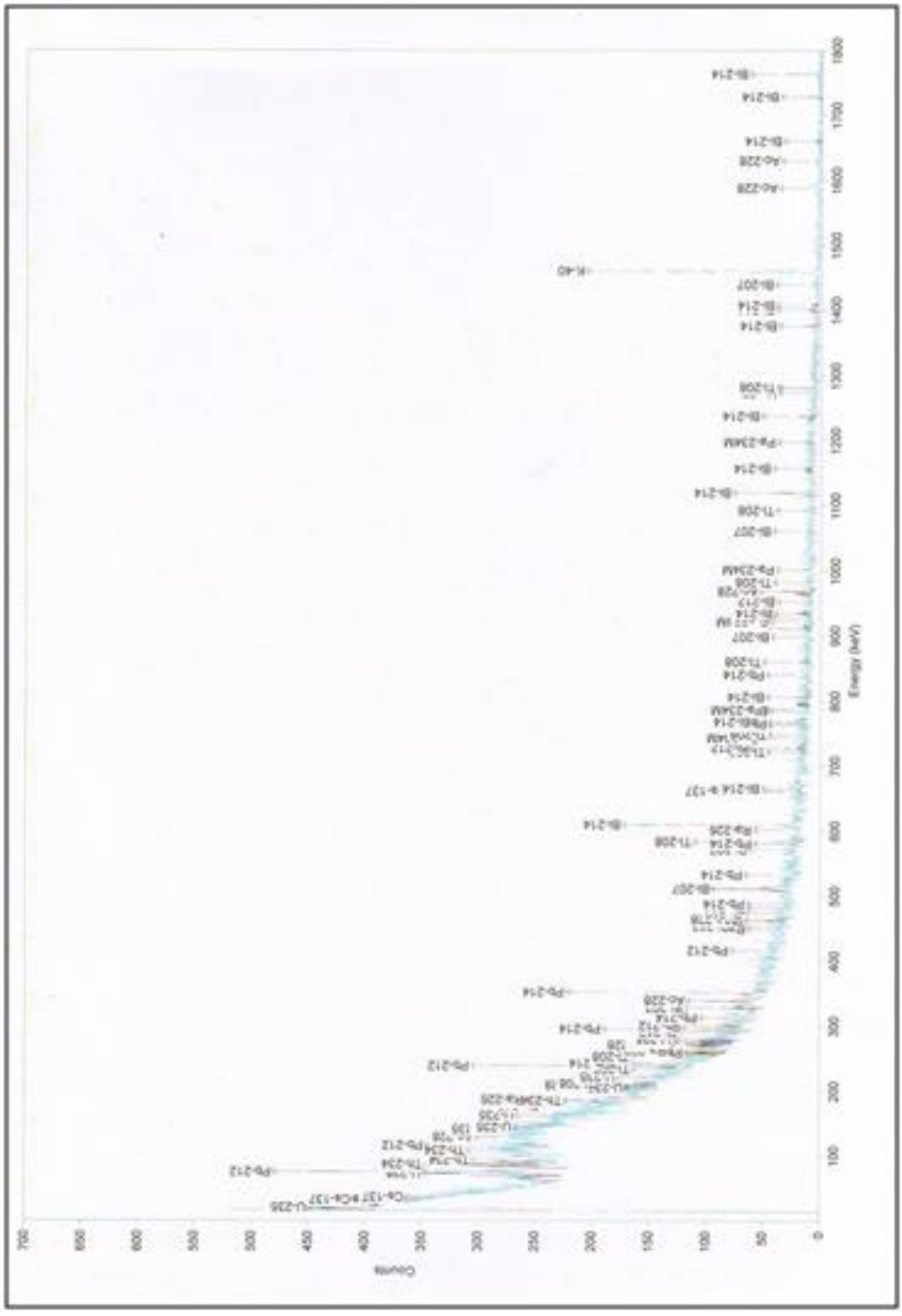
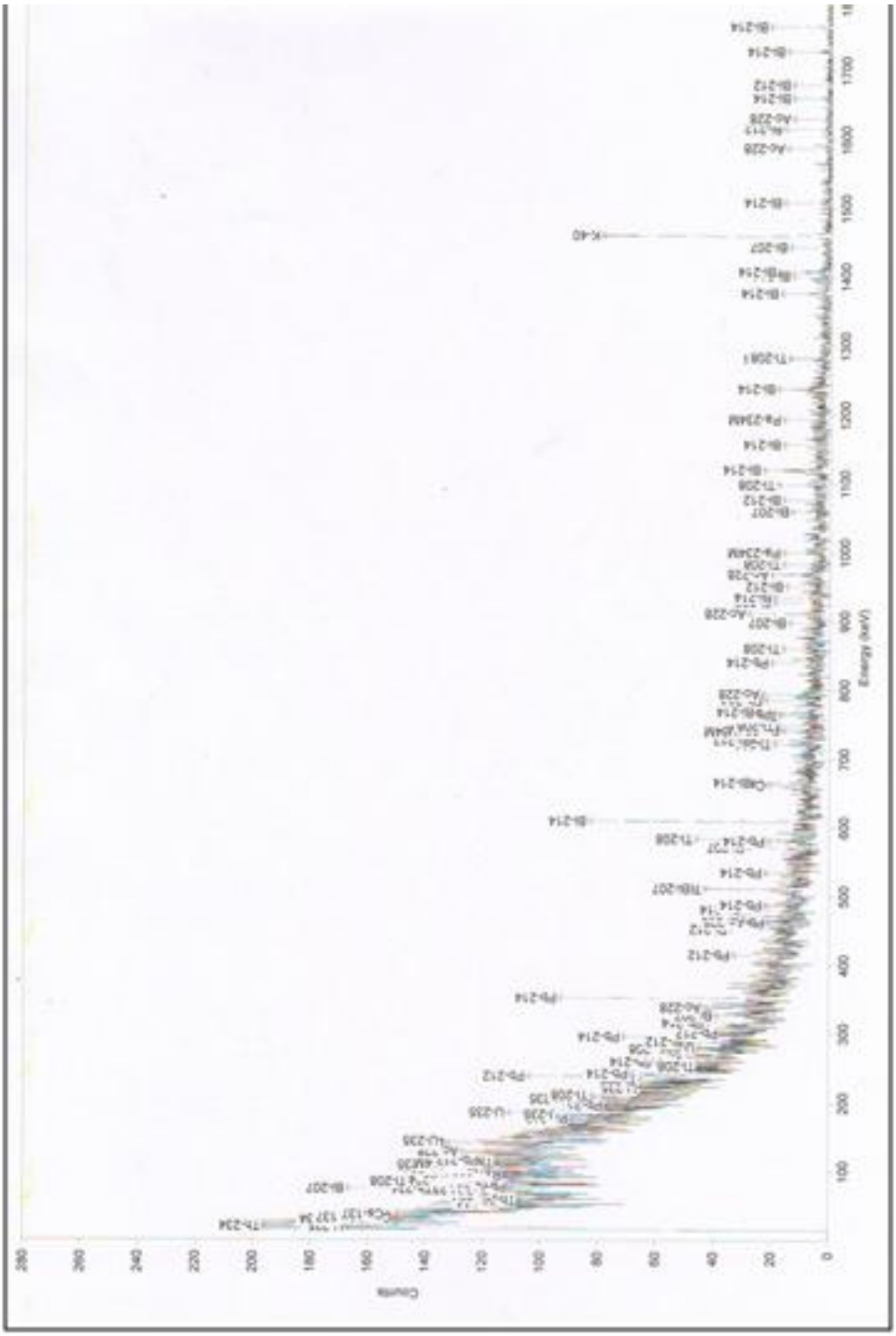


Figure (5) spectrum of radionuclides in one of the models elected from smelting furnaces



Form (6) spectrum of radionuclides in soil samples elected from the site of the basalt stone assembly

Theresultsof laboratory teststhat shown infigures (3,4,5,6) absence of a significant increasein the values ofconcentration of theradionuclideresulting from thechainsof Uranium-238and Thorium-232. This could be duethe presence ofa very small amountofcesium-137so as not toexceed2.2 Bq / kg toglobalcascading as a result ofnuclear weapons testsin addition toChernobylaccident and showed a natural concentrations for isotope of Radium -226 especially in models that have been taken from the smelting furnaces (B1,B2) ranged between (62.23 – 24.1) Bq / kg respectively but it is a clear indication of the high readings mobile devices (RadEye and FH40) from natural background in terms ofrates of radiation dosesandradioactive contaminationin fact thatRadium-226isotopewitha half-lifeof1600 yearsforisotopesemittingGamma and Alpha rays which lead dissolutionemission ofRadon gas. Radonis aradioactive gasis colorless, tasteless andodorless, which isanaturalsourceof atomic radiationandis generatedinthe decomposition ofUranium-238chain. It isthe onlyisotopewhohasthe status ofgaseous exists in differently concentrationsandin differentplaces . The scientists recently found that the long exposure to high concentrations of radon can lead to lung cancer [10]Especially in places where there is no proper ventilation. This is from one side and the other side the constant exposure for fiber rock wool by inhalation or ingestion without feeling the worker and that for being small in size it causes several diseases, including asbestosis disease, cancer in the cavity surrounding the lungs ,cancer of the larynx, stomach, intestines and rectum [11].

Thus the workers in these plants should wear personal protective equipment PPE (respirators, gloves, suits work disposable, head cover, cover shoes) and provide them personal dosimeter (TLD) examine it regularly in the Ministry of Environment / Center for radiation protection and also must replace workers who are at the site of smelting furnaces continuously in order to keep the limits of radiation doses that prescribed by the International Atomic Energy Agency (IAEA) (1mSv / year) through the apply ALARA base (As low as Reasonably Achievable) [9].

Determine whether dose rates exceed the dose limit for the public of 1mvS/y

0.65µSv/h*8 hr/day * 5day/week * 4week /month *12 month /year

1248 µSv/year = 1.248mSv/year > 1mSv/year

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