Natural radioactivity survey in Al-Jabal Al-Gharbi Mountain Region Libya

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Abstract

The measurement of natural radioactivity in a given region or country is essential to provide a reference base-line map to follow up a possible variation in future. In order to perform such measurement, the natural radioactivity was measured in different locations. The locations (50 sites) were distributed over Al-Jabal Al-Gharbi Mountain, starting from the city Al-Azeeziah in the eastern part to Wazen on the Tunisian border in the west. The measurements showed obvious variation from one site to another. The levels were fluctuating from (12.8 counts/minute) in Bir-Ayad to (45.7 counts/minute) in Gherian.

In order to investigate the cause for such variation, samples were collected from (27) sites for detailed study. The levels of natural radioactivity were determined in the laboratory, and were ranging from (58.7 Bq/kg) in Bir-Ayad to (102.1 Bq/kg) in Gherian.

The variation in measured radioactivity was related to the geological structures taken in six perpendicular sections, namely, Gharian, Yevren, Zintan, Nalut, Wazen and Al-Azeeziah taking the naturally occurred radioisotopes concentration of ^{40}K, ^{232}Th and ^{238}U present in consideration.

Keywords
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المسح الإشعاعي في منطقة الجبل الغربي- ليبيا

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الخلاصة

بهدف اعداد قاعدة بيانات عن الاشعاع الطبيعي في منطقة الجبل الغربي (ليبيا)، تم قياس النشاط الاشعاعي في (50) موقع موزعة افقيا على امتداد سلسلة الجبل الغربي ابتداءا من العزيزية شرقا وحتى وازن على الحدود التونسية غربا، حيث أظهرت القياسات تفاوتا ملحوظا، ففي بئر عياد كان معدل النشاط المقاس (12.8 عدة في الدقيقة) بينما وصل في منطقة غريان الى (45.7 عدة بالدقيقة).

ولتفسير هذا التباين تحليليا، أخذت عينات منتخبة وممثلة للتكوينات الجيولوجية المختلفة من (27) موقع متميز وتم قياس النشاط الاشعاعي الطبيعي لكل منها مختبريا حيث اظهرت القراءة للعينة الماخوذة من منطقة بئر عياد (58.7 Bq/kg) اما القراءة للعينة الماخوذة من منطقة غريان فكانت (102.1 Bq/kg). كما ربط هذا التباين بالنشاط الاشعاعي مع طبيعة التكوينات الجيولوجية ماخوذة في مقاطع عمودية (رأسية) في كل منطقة غريان، منطقة يفرن، منطقة الزنتان، منطقة نالوت، منطقة وازن ومنطقة العزيزية أعتمادا على النظائر المشعة الموجودة في كل تكوين (^{40}K, ^{232}Th, ^{238}U).

Introduction

The radiological survey is important for each country, to establish a data base for environmental purposes, and for future variation in radiation level due to one reason or another [1].

Radioactive pollution is divided into two categories, natural (primordial or cosmic) [2,3] and artificial [4]. The natural radioisotopes include (U-238), (U-235), (Th-232) and (K-40).[5-8]. Carbon-14 on other hand is produced by cosmic rays. However, the levels of these radioisotopes are varying from one region to another in soil and rocks, according to their geological structures [9].

The radiological survey of the Libyan territories is important, especially in Jabal Al-Gharbi region. Its importance is related to its height in the desert at the western part near the Tunisian border. The possibility of a nuclear accident in nearby European countries, namely France and Italy is feasible. Another factor was taken into consideration when performing this survey, which is the versatility of the geological structures of this mountainous series [10].

Many countries had established similar radiological survey and constructed useful base line maps and data base. These can be consulted at need and updated continuously to safeguard the environment [Table-I].

Table-I: Radioactivity levels at different countries.

Researcher	Country	Radioactivity levels (Bq/kg)					Ref.
		^{137}Cs	^{40}K	^{226}Ra	^{232}Th	^{238}U	
Myrik (1983)	USA	-	-	40.7	37	36.3	[11]
Luo (1985)	China	-	429	135	224	119	[12]
Mollah (1986)	Bangladesh	6.5	19.6	-	51.8	62.6	[13]
Koster (1988)	Germany	-	120-700	-	11-77	47.5	[14]
Megumi (1988)	Japan	-	75-1400	-	5-185	5-130	[15]
Moran (1988)	Ireland	-	350	-	37	26	[16]
Southerland (1990)	Ireland	10-12.6	471-502	-	31.2	31.4-34.4	[17]
Sunta (1990)	India	-	100	1000	7000	-	[18]
Zigiang (1992)	China	-	729	69	96.2	-	[19]
Guna (1992)	Hong Kong	-	817	147	77	92	[20]
E. Khabis (1999)	Ramadi-Iraq	10-12	-	-	-	-	[21]
S. Al-Tikriti (1999)	Tikrit-Iraq	6-10	-	-	-	-	[22]

Measurements and Results

Jabal Al-Gharbi mountain starts from Al-Azeeziah North-East to Wazen West at the Tunisian border, and from Jfarah valley at the bottom to Nalut at top. Its height about 800 m above the sea level (Fig.1).

This region was surveyed by a portable nuclear radiation detector at (50) selected locations, both horizontally and vertically.

These locations were carefully selected according to their geomorphology and geological structure. The count rates of these measurements (in-situ) were

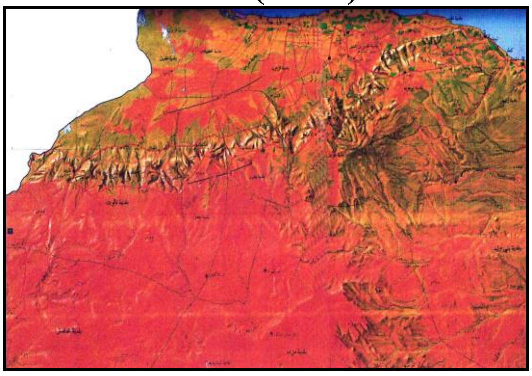

Fig.1:Map of Al-Jabal Al-Gharbi / Libya.

tabulated with description of the locations in Table-II.

Samples were carefully picked-up from (27) sites for further laboratory investigation. The samples were selected according to their abnormalities during the field measurements.

These samples were ground and the powder of each sample was mixed thoroughly to ensure homogeneity. Then, the powder was compacted as pellets of about (20 g) each (Fig.2).

The pellets were measured individually by a special low-level Geiger-Muller radiation detector at the laboratory. The results were tabulated as shown in (Table-III).

A base line map was constructed on the surveyed region, horizontally and vertically to be correlated with the geological structure of each location (Fig.3) and (Fig.4).

Fig.2: The compacts of selected Samples.

Discussion and Conclusions

Radiological survey at the field showed variations from average (12.8 c/m) at

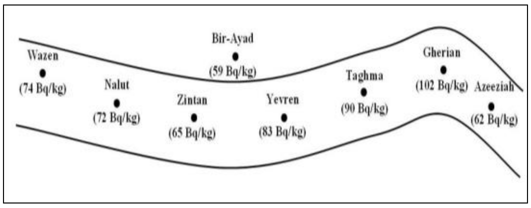

Fig.3:Diagram for Field Radiological Survey (Horizontal Projection Over Jabal Al-Gharbi Mountain, Libya .

Bir-Ayad which is composed mainly from Gypsum rocks to average (45.7 c/m) at Gherian were the region composed of Igneous rocks from a nearby old volcan. Laboratory investigations gave corresponding average results of (58.8 Bq/kg) and (102.1 Bq/kg) respectively.

The reason for such variation is explained by the presence of one or more radioisotopes, namely (U-238) (and its by product Ra-226), (U-235), (Th-232) and (K-40). These radioisotopes are naturally occurring in soil and rocks at the measurements locations.

The identification of the rocks from geomorphological point of view gave a clue about the possible presence of a specific radioisotope [23].

However, to ensure these first hand conclusions, the pellets can be analyzed chemically or by x-ray fluorescence to identify the elements present in each pellet [23].

For further assurance, Gamma-ray spectroscopy can be utilized to identify the gamma lines of the radioisotopes present in each pellet [23].

Present results in Table-II and Table-III are in agreement with geological knowledge. It is well known that phosphorous containing rocks (such as carnotite) are rich with uranium. Volcanic rocks (such as phonolite and Monozite) contain high concentration of thorium. On the other hand, sands contain high levels of washed out potassium [23].

Table-II: Average Natural Radioactivity Al-Jabal Al-Gharbi.

No.	Location	Geological Description and Structure	Average c/m
1	Zintan	Dolomite/Lime Stone (Nalut Structure)	13.40
2	Zintan	Dolomite (Nalut Structure)	13.85
3	Zintan	Sand Stone (Kikla structure)	14.50
4	Bir-Ayad	Gypsum (Bir Al-Ghanam Structure)	12.80
5	Yevren	Yevren Marl (Sidi Al-Said Structure)	23.45
6	Wazen	Sand/Clay Rocks (Kikla structure)	25.60
7	Nalut	Lime Stone (Nalut Structure)	15.15
8	Nalut	Yevren Marl (Sidi Al-Said Structure)	16.65
9	Nalut	Dolomite Ain Tibbi (Sidi Al-Said Structure)	13.50
10	Nalut	Sand (Kikla structure)	17.05
11	Taghma	Dolomitic Lime Stone, Ain Tibbi (Sidi Al-Said Structure)	16.95
12	Taghma	Sand/Clay Stones (Kikla structure)	27.75
13	Gherian	Dolomitic Lime Stone (Nalut Structure)	14.35
14	Gherian	Yevren Marl (Sidi Al-Said Structure)	17.45
15	Gherian	Lime Stones Ain Tibbi (Sidi Al-Said Structure)	15.30
16	Gherian	Sand and Rocks Layer (Rijban/Kikla structure)	16.70
17	Gherian	Marl lime Stones (Abu Ghailan Structure)	19.70
18	Abu-Risha	Red Sand Stone (Abu Risha Structure)	19.05
19	Abu-Risha	Phosphorous Rocks (Below Abu Shiba Structure)	29.90
20	Gherian	Dolomitic Lime Stone (Azeeziah Structure)	18.35
21	Gherian	Mikae Sand Rocks (Kirsh Structure)	23.80
22	Gherian	Phonolite Volcanic Rocks (Abu Ghannosh Structure)	45.70
23	Zintan	Marl-Lime Stone (Tighrina Palace Structure)	15.30
24	Zintan	Dolomitic Lime Stone (Nalut Structure)	15.95
25	Zintan	Yevren Marl Rocks (Sidi Al-Said Structure)	17.35
26	Zintan	Dolomitic Lime Stones Ain Tibbi (Sidi Al-Said Structure)	14.85
27	Azeeziah	Grey Dolomite Rocks (Azeeziah Structure)	16.25
28	Taghma	Gypsum Stone (Nalut Structure)	15.45
29	Yevren	Dolomitic Lime Stone (Nalut Structure)	15.55
30	New Zintan	Lime Rocks (Mizda Structure)	15.55
31	Rijban	Lime Rocks (Mizda Structure)	15.50
32	Jado	Clay Rocks (Sidi Al-Said Structure)	18.95
33	Jinoun	Marl Lime Rocks (Tighrina Palace Structure)	15.75
34	Rijban	Lime Stony Rocks (Tighrina Palace Structure)	14.75
35	Rijban	Gypsum/Clay Land (Nalut Structure)	17.85
36	Riyayna	New Deposits (Al-Haj Palace Cover)	19.15
37	Riyayna	Dolomitic Lime Stone (Nalut Structure)	14.00
38	Ghwalish	New Deposits (Tighrina Palace Cover)	17.15
39	Kikla	Marl Lime Rocks (Tighrina Palace Structure)	15.35
40	Jinoun	Sand/Clay Rocks (Kikla Structure)	17.75
41	Shakshook	New Deposits (Kikla Structure Cover)	14.25

Continued

No.	Location	Geological Description and Structure	Average c/m
42	Al-Haj P.	Conglomorate (Al-Haj Palace Structure)	17.20
43	Haraba	New Deposits of Sand and Gravel (Mizda Structure)	17.30
44	Tendmera	Marl Lime Stones (Tighrina Structure)	16.60
45	Temzene	Marl Lime Stones (Tighrina Palace Structure)	15.00
46	Kabau-up	Outcrope Rocks (Nalut Structure)	13.10
47	Kabau-down	New Deposits (Tighrina Palace Cover)	16.40
48	Hawamid	New Deposits/Broken Rocks (Tighrina Palace Cover)	16.40
49	Pre Nalut	New Deposits/Broken Rocks (Tighrina Palace Cover)	16.55
50	Nalut quarry	(Purple/Red) Clay (Kikla structure)	19.65

Table-III: Laboratory Measurements of Natural Radioactivity.

No.	Location	Geological Description and Structure	Average	
			c/m	Bq/kg
1	Zintan	Dolomite/Lime Stone (Nalut Structure)	15.20	63.3
2	Zintan	Bright Dolomitic Stone (Nalut Structure)	15.60	65.0
3	Zintan	Sand Stone (Kikla structure)	15.25	63.5
4	Bir-Ayad	Gypsum Rocks (Bir Al-Ghanam Structure)	14.10	58.8
5	Yevren	Marl (Sidi Al-Said Structure)	19.90	82.9
6	Wazen	Sand/Clay Rocks (Kikla structure)	17.95	74.0
7	Nalut	Lime Stone (Nalut Structure)	16.50	68.8
8	Nalut (A)	Marl (Sidi Al-Said Structure)	17.80	74.2
9	Nalut (B)	Dolomitic Stone (Sidi Al-Said Structure)	15.90	66.3
10	Nalut (Q)	Sand (Kikla structure)	16,20	67.5
11	Taghma (R)	Dolomitic Lime Stone (Sidi Al-Said Structure)	14.85	61.9
12	Taghma (D)	Sand/Clay Stones (Kikla structure)	21.50	89.6
13	Gherian up	Dolomitic Lime Stone (Nalut Structure)	16.40	68.3
14	Gherian (R)	Marl (Sidi Al-Said Structure)	16.35	68.1
15	Gherian (R)	Lime Stone (Sidi Al-Said Structure)	17.15	71.5
16	Gherian (R)	Sand Stone Layer (Kikla structure)	15.35	64.0
17	Gherian (D)	Marl/lime Rocks (Bir Al-Ghanam Structure)	15.40	64.2
18	Abu-Risha	Red Sand Stone (Abu Risha Structure)	20.10	83.8
19	Abu-Risha (Q)	Phosphorous Rocks (Abu Shiba Structure)	24.30	101.3
20	Gherian (D)	Dolomitic Lime Stone (Azeeziah Structure)	15.00	62.5
21	Gherian (D)	Sand Rocks (Kirsh Structure)	17.20	71.7
22	Gherian (T)	Volcanic Rocks (Abu Ghannosh Phonolite)	24.50	102.1
23	Zintan	Marl Lime Stone (Tighrina Palace Structure)	14.90	62.1
24	Zintan (R)	Dolomitic Lime Rocks (Nalut Structure)	16.60	69.2
25	Zintan	Marl Rocks (Sidi Al-Said Structure)	15.90	66.2
26	Zintan	Dolomitic Lime Stones (Sidi Al-Said Structure)	15.35	64.0
27	Azeeziah Gravel Querry	Grey Dolomite Rocks (Azeeziah Structure)	14.75	61.5

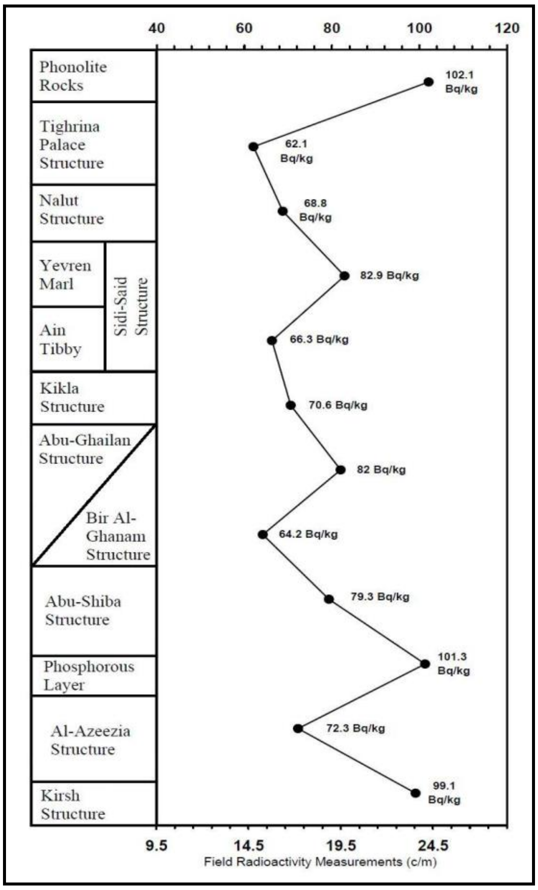

Fig.4:Count Rate at Gherian Cross Section

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