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Quantitative estimation of Uranium in Geological samples

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ABSTRACT

A measurement of Gamma (γ) or Beta (β) activity gives the equivalent (U_3O_8) content of a rock sample which may differ from the actual (U_3O_8) present, due to the disequilibrium of Uranium series or due to the presence of Thorium or both. A relation between the Beta (β) and Gamma (γ) (U_3O_8) equivalent activities as compared to a Uranium standard in equilibrium has been worked out which gives and the presence of Thorium. The correction due to the variations in density and the grain size is minimized in the experimental set up used here.It is common experience in radio-assay work that Beta (β) or Gamma (γ) activity of a field sample measured in terms of Uranium may or may not give the actual Uranium content of the sample. It so happens that the sample showing a higher Beta (β) or Gamma (γ) activity may actually have a smaller Uranium content. This leads to the conclusion that the Beta (β) or Gamma (γ) activity of the sample is not a true measure of its actual Uranium content. It is because the Uranium series in the sample is not always in equilibrium with its many products of disintegration called the Daughter Elements, all of which contribute more or less towards the composite activity of the sample. Besides, there might be in addition to the Uranium series other radioactive series present, the most important of these being Thorium. Thus, the measurement of Beta (β) or Gamma (γ) activity of a sample only measures the equivalent activity in terms of Uranium standard and the content so measured is called the Uranium Equivalent denoted as eU_3O_8. This also does not show that Uranium mineral is necessarily present in the sample; the entire activity of the sample may be due to Thorium. Beta (β) or Gamma (γ) radio-assay, therefore, leaves one with a large amount of uncertainty in the assessment of a sample. But if the sample is in equilibrium and also no Thorium is present the eU_3O_8 as measured by Beta (β) or Gamma (γ) assay will give the actual Uranium content.

Keywords **- Gamma (γ), Beta (β) activity, U_3O_8**

I. INTRODUCTION

A β/γ Method is mainly used for calculating the percentage of actual uranium in a sample. It is a very advanced method to calculate and know the uranium content in natural rocks. By using this β/ γ method very vast using for calculate uranium it gives the good and exact percentage in rocks.
In uranium exploration the field measurement are done by using instrument which use of detection. In fact these gammas (γ) comes from the daughter products of uranium series, Thorium (Th) series and. Therefore the measurement of actual uranium based on gamma (γ) activity can be estrous due to disequilibrium in uranium series or presence of Thorium (Th) series or all of them.

The purpose of the report is an attempt has been made to work out a treatment which would enable a fairly accurate [1] estimate of the actual uranium content, irrespective of the condition of the equilibrium and also allowing for the effect of the presence of Thorium that may have on these measurements.

Martin Klaproth, a German chemist, discovered the element uranium in 1789.Henri Becquerel, a French physicist, discovered radioactivity in 1896. This led to further into the nature of matter and gave birth to nuclear physics. The development of techniques for the measurement of radioactivity soon followed [2]. The first tube detectors were developed the first decade of the twentieth century, and these led to the development of portable field instruments. Measurement sensitivity increased significantly when scintillation detectors were developed during the 1940s.

Intensive uranium exploration led to the first airborne radiometric surveys in the USA, Canada and former USSR in 1947 and in Australia in 1951. Airborne, ground and laboratory gamma ray spectrometry were developed and applied to mineral exploration and environmental monitoring in the 1960s and 1970s. This enabled the in situ estimation of the radioelement concentrations of potassium, uranium and thorium in the field [3]. Subsequent developments included the use of multichannel analyzers, digital recording, the development of semiconductor detectors, and improvements in data processing.

Everything in the world, and everybody in the word, is composed of different types of matter (chemical elements). The smallest part of each element is called the "Atom". An atom is so small that it can be seen only with the most powerful microscope. But the atom is the core of every substance in the universe. Atomic energy is produced by fission (splitting of the radioactive-elements like uranium) or by fusion (like colliding and fusing of two deuterons to form helium) of atomic nuclei, with matter being converted into energy in either process.

Mineral is a naturally occurring inorganic substance, with fixed range in chemical composition, and is usually obtained by mining. Atomic minerals are the minerals of radioelements mainly Uranium (U) and Thorium (Th) and those in which these radio-elements are in minor to trace amount [4].

II. METHODOLOGY

2.1 Beta (β) gamma (γ) method

Measurement of parent Uranium concentration is done by another technique called "BETA GAMMA METHOD"

Beta gamma method is a simple technique which measures uranium concentration irrespective of disequilibrium in uranium series and presence of thorium in the sample A measurement of Gamma (γ) or Beta (β) activity gives the equivalent (U_3O_8) content of a rock sample which may differ from the actual (U_3O_8) present, due to the disequilibrium of Uranium series or due to the presence of Thorium or both. A relation between the Beta (β) and Gamma (γ) (U_3O_8) equivalent activities as compared to a Uranium standard in equilibrium has been worked out which gives and the presence of Thorium. The correction due to the variations in density and the grain size is minimized in the experimental set up used here.It is common experience in radio-assay work that Beta (β) or Gamma (γ) activity of a field sample measured in terms of Uranium may or may not give the actual Uranium content of the sample. It so happens that the sample showing a higher Beta (β) or Gamma (γ) activity may actually have a smaller Uranium content. This leads to the conclusion that the Beta (β) or Gamma (γ) activity of the sample is not a true measure of its actual Uranium content [5]. It is because the Uranium series in the sample is not always in equilibrium with its many products of disintegration called the Daughter Elements, all of which contribute more or less towards the composite activity of the sample. Besides, there might be in addition to the Uranium series other radioactive series present, the most important of these being Thorium. Thus, the measurement of Beta (β) or Gamma (γ) activity of a sample only measures the equivalent activity in terms of Uranium standard and the content so measured is called the Uranium Equivalent denoted as eU_3O_8. This also does not show that Uranium mineral is necessarily present in the sample, the entire activity of the sample may be due to Thorium. Beta (β) or Gamma (γ) radio-assay, therefore, leaves one with a large amount of uncertainty in the assessment of a sample. But if the sample is in equilibrium and also no Thorium is present the eU_3O_8 as measured by Beta (β) or Gamma (γ) assay will give the actual Uranium content. It has, however, been found that, though a measurement of Beta (β) or Gamma (γ) activity will not give the actual Uranium content unless the sample be in equilibrium and no Thorium is present, a combination of the two measurements i.e. Beta (β) and Gamma (γ) activities can be made to yield the true value of the uranium content of the sample. This was first attempted by Lapointe et al. (1) and Thommeret (2) independently and later by Eichholz et al. (3). [6] The method can be applied to the case when both Uranium and Thorium minerals are present in the sample and also when the Uranium series is out of equilibrium. This is rendered possible by the fact that the Gamma (γ) activity of an Uranium mineral is almost entirely contributed by the Radium group of the series of daughter products and that Thorium minerals not being easily leachable and Thoron having a very short life, the Thorium series is not expected to be out of equilibrium.

A study of the Uranium series [7] will show that practically all the detectable Gamma (γ) radiation (1.76 Mev and 2.19 Mev) comes from the Bi^{214} (RaC). The Gamma (γ) radiation can be shut out from the measurement by the use of suitable absorber, leaving only the Gamma (γ) radiation from RaC. The measurement of the Gamma (γ) activity of a Uranium sample therefore means the measurement of the Radium group only. From the point of view of Gamma (γ) activity the Uranium series may be taken as composed of two groups.

i) Uranium group which is poor in Gamma (γ) activity and whatever Gammas it emits are of low energy and can be blocked out by a suitable absorber.

ii) Radium group [8] which mainly contributes to the Gamma (γ) activity in a radio-assay.

Radium having [9] [10] a fairly long life, it is possible for these groups to exist independently for some time, in nature, daughter elements of Radium being short lived. From the point of view of Beta (β) activity, the Gamma (γ) B count of a sample is the sum of the contribution from both these groups. The main Beta (β) emitting elements in the Uranium group being Pa^{234} (UX2) and the Radium group Bi^{214} (RaC), Bi^{210}(RaE) and Pb^{214}(RaB). When the Uranium series is in equilibrium, the elements of the two groups, Uranium and Radium, bear a constant quantitative ratio to each other ; from a Gamma (γ) measurement alone which in fact measures the Radium group, the Uranium group can be inferred and the Uranium content correctly estimated by a comparison with the Gamma (γ) activity m it is again possible to estimate the Uranium content. Thus, for an Uranium sample in equilibrium a Beta (β) or Gamma (γ) measurement alone will suffice to find out the actual Uranium content. If, however, the Uranium series in the sample is not in equilibrium the ratio Uranium group / Radium group is not known and may have any value so that the measured Gamma (γ) or Beta (β) activity will not give the true Uranium content and all that we shall know, in such cases, is the eU_3O_8 of the sample which may differ from the actual Uranium content considerably. The presence of Thorium introduces another uncertain factor in the problem and renders the estimation even more difficult.

There are several factors which may disturb the equilibrium in an Uranium mineral. One is the change in the Radon content. This particular element being gaseous is easily disturbed but the equilibrium disturbed due to the removal of Radon is quickly restored and in the radio-assay this can be taken care of. Secondly as the series consists of different elements they respond differently to chemical changes. The Uranium from a mineral might get leached out and be repreciated elsewhere leaving the original material deficient in Uranium as compared to the Radium group, which is not affected to the same extent. The reprecipitated Uranium will be deficient in the Radium group. The Radium group being short lived as compared to the Uranium group will disintegrate faster and will return to equilibrium earlier, on the other hand reprecipited Uranium will take much longer time to do so. The samples in which the Radium group is in excess are therefore not met so frequently in nature whereas it is more common to come across samples

of the second type where Uranium group is in excess. Now, Beta (β) or Gamma (γ) measurement in the latter type of samples will give an eU_3O_8 content which will be less than the actual Uranium content, in the former type of samples the eU_3O_8 value be far in excess of the actual Uranium content. The true Uranium content cannot, therefore, be correctly determined unless this variation is taken into account.An attempt has been made to work out a treatment which would enable a fairly accurate estimate of the actual Uranium content, irrespective of the conditions of equilibrium and also allowing for the effect the presence of Thorium may have on these measurements.

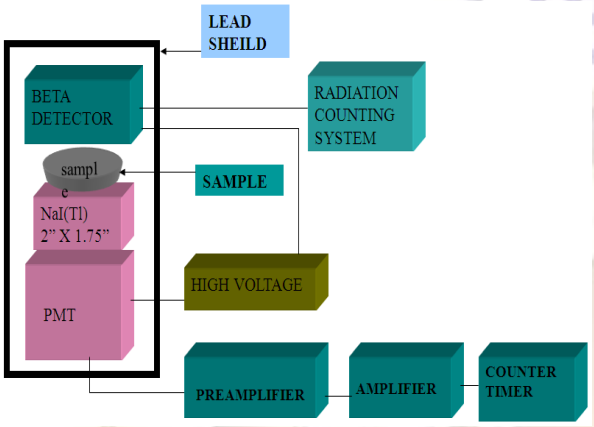

Figure 1: Block Diagram of Beta Gamma method

The above block diagram shows the set up of the BETA/GAMMA METHOD.

It consists of Detectors, Amplifier, Pre- -Amplifier, Counter Timer, Radiation counting system and High Voltage.

2.2 Detectors

From the samples BETA (β) rays or GAMMA (γ) rays are extracted using NaI (Tl) 2" X 1.75" detector for Gamma rays, and G.M Tube for Beta rays and correspondingly the counts in the sample via display in the counter timer.

2.3 Detecting for Gamma (γ) rays

Scintillation counters consist of a scintillator and a photomultiplier. An incident gamma ray photon interacts with the material of the scintillation crystal to produce scintillations. These photons of visible light induce the ejection of electrons from the photocathode of the attached photomultiplier. Their number multiplies progressively at dynodes of the photomultiplier; and an electron cloud strikes the anode. This induces a negative voltage pulse as output, with amplitude proportional to the energy of the incident photon.

2.4 Detecting for Beta (β) rays

GM counters make use of the progressive growth of ionization in a strong Electric field between the anode and the cathode. An incident photon interacts with the Cathode and releases an electron that may be directed into the GM tube. The growth of Ionization between the anode and the cathode amplifies the signal and generates an electric current between the electrodes. This results in a voltage pulse at the anode output of the GM counter. The multiplication coefficient of the gas ionizing chain reaction is of the order of 10^6,and the output pulse is not proportional to the absorbed gamma ray energy. The detection efficiency of GM counters is very low (less than 2%) and the dead time is of the order 10^{-4} s.

2.5 Caluculation of C

If N_γ is the total γ counts from Uranium sample, then,

$N_\gamma = \frac{Ra}{n_\gamma} + \frac{U}{n_\gamma}$, where, $\frac{Ra}{n_\gamma}$ and $\frac{U}{n_\gamma}$ are the Gamma contributions due to the Radium and Uranium groups.

Since, all the low energy Gamma rays are cut off, $\frac{U}{n_\gamma} = 0$,

and $N_\gamma = \frac{Ra}{n_\gamma}$ ..... (1)

Similarly, for the Beta measurement, $N_\beta = \frac{Ra}{n_\beta} + \frac{U}{n_\beta}$, where N_β is the total Beta counts and $\frac{Ra}{n_\beta}$ and $\frac{U}{n_\beta}$ are the Beta contributions due to the Radium and Uranium groups respectively.

If the sample is in equilibrium, the Radium and the Uranium groups maintain a constant proportion, i.e.

$\frac{Ra}{U}$ = C; a constant..... (2) So that,

$N_\beta = (1 + C)\frac{U}{n_\beta}$ or $\frac{U}{n_B} = \frac{NB}{(1+C)}$ .....(3)

The quantity of Uranium. U, may be written as,

$U = \frac{KNB}{(1+C)}$ ..... (4), where, K = Constant

Taking an Uranium sample in equilibrium as standard, we have,

$U^S = \frac{K\,N^S B}{(1+C)}$ ..... (5)

Where the notation << S >> refers to the standard.

Dividing (4) and (5), we have,

$$U = \frac{NB}{N^s B}\ U^S \quad \text{..... (6)}$$

Now, let us take the case of a sample, which is out of equilibrium. In this case, the ratio of $\frac{Ra}{U}$ will not be equal

to the constant << C >> as for a sample in equilibrium, but will differ from << c >> by a factor, say, << ρ >>

i.e. $\frac{Ra}{U} = \varrho c$..... (6.7), giving $U = \frac{KNB}{(1+\rho c)}$ ..... (8),

for the sample

Dividing (8) by (5), we get,

$$U = \frac{NB}{N^s B}\ \frac{(1+c)}{(1+\rho c)}\ ,U^S \quad \text{..... (9)}$$

Now equation (6.7) can be written as,

$\frac{nB^{Ra}}{nB^U}$ α. ρ c = $\frac{dN_\gamma}{nB^U}$, where, <<d>> is a constant,

For the standard, in equilibrium, the corresponding relation is,

$$\frac{dN_\gamma^S}{nB^{US}} = C,$$

Where, N^S and nB^{Us} being the total γ counts from the standard and ϱ counts from the Uranium group, in the standard.

Dividing one by the other, we get

$$\frac{N_\gamma}{N^U B}, \frac{nB^{Us}}{N_\gamma^S} = \rho \text{ or } \frac{N_\gamma}{N_\gamma^S}, \frac{U^S}{U} = \rho$$

Substituting this value of << ρ >> in equation (9) and simplifying, we get

$$U = \frac{U^S NB}{N^S B}(1+C) — \frac{N_\gamma}{N_\gamma^S} U^S C \quad \text{..... (10)}$$

$$\text{Or } U = (eU_3O_8)\ B\ (1+C) — (eU_3O_8)\ \gamma\ C \text{..... (11)}$$

Where, (eU_3O_8) B and γ are the Uranium equivalents of the sample in terms of B and γ activities.

The value of the constant <<C>> can be calculated by assaying a sample of known Uranium content. Now, let us consider the case when Thorium is also present in the sample. Thorium contributes to both B and γ counts of the sample and let these be nB^{Th} and n_γ^{Th}. The counts due to the Uranium series will then be $NB.nB^{Th}$ and $N_\gamma . n_\gamma^{Th}$ .NB and N_γ being the total B and γ counts of the sample.

Thus,

$$U = U^S \frac{NB - nB^{Th}}{N^S B}(1+C) — \frac{N_\gamma - N_\gamma^{Th}}{N_\gamma^S} C\ U^S$$

$$= [U^S \frac{NB}{N^S B}(1+c) — \frac{N_\gamma}{N_\gamma^S} U^S C] — [U^S \frac{nB^{Th}}{N^S B}(1+C) — \frac{n_\gamma^{Th}}{N_\gamma^S} U^S C]$$

It has been found experimentally by taking a Thorium sample, free from Uranium an Uranium standard, that,

$$\frac{N_\gamma^S}{N^S B}\ \frac{nB^{Th}}{n_\gamma^{Th}} = \frac{C}{(1+C)}$$

Thus, the last bracketed term is negligible, and the above equation (11) gives a good even though Thorium is present in the sample.

III. DATA STANDIZATION

First switch on the experiment panel, for on some time to get the stabilization of the instrument forget accurate values.

1) Take the back ground values for 1000sec of Beta and Gamma counts, take the 5 readings morning 3, afternoon 1 and evening 1 value.

2) Next take the IAEA 0.047% U_3O_8 50 grams sample and take the 3values for 500sec.

3) Next take New Disequilibrium standard of 0.85% 50 grams sample and take the 3 values for 500sec.

4) Then finally take the unknown sample of 50 grams take 3 readings for 1000sec.

Then find the Uranium content in the unknown sample by using the below formulae and take that readings from the above readings.

$$U_3O_8 = (1+C)\ U_\beta — C\ U_\gamma$$

5) Next the background values normalized to 200sec and take the average of the background.

6) Then do the same the above normalized to 200sec and take the average and find the f U_γ and f U_β.

$$F\ U_\beta = \frac{Grade of Equilents tan derd}{N_E^\beta}$$

$$N_E^{\beta} = T_E^{\beta} - Background^{\beta}$$

$$F\ U_{\gamma} = \frac{Grade}{N_E^{\gamma}}$$

$$N_E^{\gamma} = T_E^{\gamma} - Background^{\gamma}$$

7) Finally do the same for the Disequilibrium standard i.e. is also normalized to 200sec and take the average values of Beta and Gamma count and find the U_{β} and U_{γ} .

For finding U_{β} and U_{γ} first calculate the $N^{\beta}_{Disequilibrium}$ (average value of Beta of disequilibrium standard) and $N^{\gamma}_{Disequilibrium}$ (average value of Gamma of disequilibrium standard).

$$U_{\gamma} = N^{\gamma}_{DISEQUILIBRIUM} \text{ X } F_{\gamma}$$

$$U_{\beta} = N^{\beta}_{Disequilibrium} \text{ X } F_{\beta}$$

For the above all values sub suite in the equation

$U_3O_8 = (1+C)\ U_{\beta}$ — $C\ U_{\gamma}$And find the value of C.

In the above know the all values expect C that is will find from it.

$$C = \frac{U_3O_8 - U_{\beta}}{U_{\beta} - U_{\gamma}}.$$

8) In the above same way can calculate the U_3O_8 in a given unknown sample. In the unknown sample i.e. is also normalized to 200sec and takes the average values of Beta and Gamma count and find the U_{β} and U_{γ} .

For finding U_{β} and U_{γ} first calculate the N^{β}_{Sample} (average value of Beta Of unknown sample) and N^{γ}_{Sample} (average value of Gamma of unknown sample)

$$U_{\gamma} = \frac{\left(N^{\gamma}_{Sample}\right)}{.}\ \text{X } F_{\gamma}$$

$$U_{\beta} = N^{\beta}_{Sample} \text{ X } F_{\beta}$$

For the above all values sub suite in the equation

$U_3O_8 = (1+C)\ U_{\beta}$ — $C\ U_{\gamma}$

And find the value of U_3O_8 of the unknown sample.

IV. RESULTS

4.1 SAMPLE DETAILS

- **Total number of samples** : 4
- **No. of borehole** : CTR-312C
- **Area** : Chitrial
- **Distract** : Nalgonda
- **State** : Andhra Pradesh
- **Nature of sample** : Borehole core sample.

Table 1: Average: 18% In favor of Daughter.

S.NO	SAMPLE NAME	%eU$_3O_8$	%U$_3O_8$	% d.f	INTERPRETATION
1	CTR-312C\B\2\25	0.010	0.058	-42	In Favor Of Daughter
2	CTR-312C\B\2\26	0.024	0.026	8.9	In Favor Of Parent
3	CTR-312C\B\2\27	0.018	0.019	2.2	In Favor Of Parent
4	CTR-312C\B\2\30	0.081	0.059	-27	In Favor Of Daughter

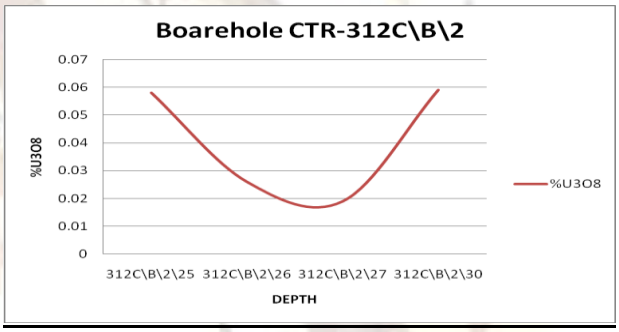

Figure 2 Graph between %U_3O_8 Vs Sample Depth

4.2 SAMPLE DETAILS

- **Total number of samples** : 5
- **No. of borehole** : CTR-114
- **Area** : Chitrial
- **Distract** : Nalgonda
- **State** : Andhra Pradesh
- **Nature of sample** : Borehole core sample.

Table 2: Average: 209% In Favor Of Parent.

S.NO	SAMPLE NAME	%eU$_3O_8$	U$_3O_8$	% OF d.f	INTERPRETATION
1	CTR\114\54.5-55.0	256	110	-57	In Favor Of Daughter
2	CTR\114\55.0-55.5	3651	6805	86	In Favor Of Parent
3	CTR\114\55.5-56.0	599	995	66	In Favor Of Parent
4	CTR\114\56.0-56.5	238	431	81	In Favor Of Parent
5	CTR\114\56.5-57.0	412	552	33	In Favor Of Parent

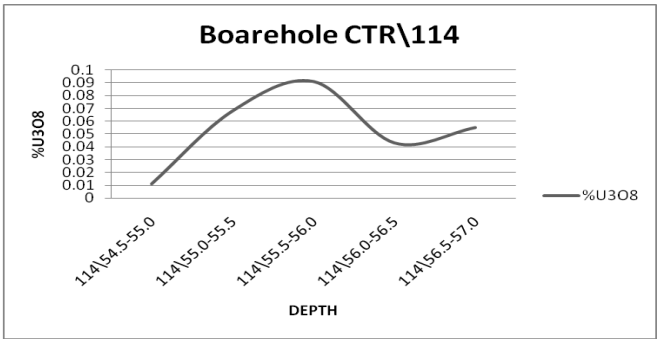

Figure 3: Graph between $\%U_3O_8$ Vs Sample Depth

4.3 SAMPLE DETAILS

- **Total number of samples** : 8
- **No. of borehole** : CTR-149C
- **Area** : Chitrial
- **Distract** : Nalgonda
- **State** : Andhra Pradesh
- **Nature of sample** : Borehole core sample.

Table 3: Average: 135% In favor of Daughter.

S.NO	SAMPLE NAME	$\%eU_3O_8$	$\%U_3O_8$	% d.f	INTERPRETATION
1	CTR\149C\5	0.010	0.056	-46	In Favor Of Daughter
2	CTR\149C\6	0.077	0.090	16	In Favor Of Parent
3	CTR\149C\8	0.091	0.042	-53	In Favor Of Daughter
4	CTR\149C\9	0.089	0.054	-39	In Favor Of Daughter
5	CTR\149C\10	0.019	0.021	08	In Favor Of Parent
6	CTR\149C\11	0.020	0.022	07	In Favor Of Parent
7	CTR\149C\12	0.013	0.086	-33	In Favor Of Daughter
8	CTR\149C\15	0.011	0.012	05	In Favor Of Parent

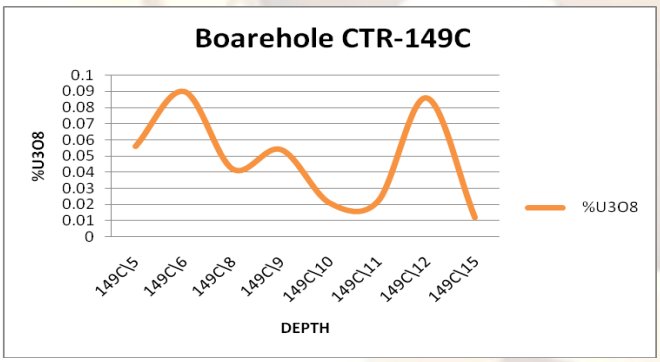

Figure 4: Graph between $\%U_3O_8$ Vs Sample Depth

4.4 SAMPLE DETAILS

- **Total number of samples** : 6
- **No. of borehole** : CTR-150C
- **Area** : Chitrial
- **Distract** : Nalgonda
- **State** : Andhra Pradesh
- **Nature of sample** : Borehole core sample.

Table 4: Average: 44% In favor of Daughter.

S.NO	SAMPLE NAME	$\%eU_3O_8$	$\%U3O8$	% d.f	INTERPRETATION
1	CTR\150C\32	0.012	0.010	-11	In Favor Of Daughter
2	CTR\150C\34	0.0120	0.09	-23	In Favor Of Daughter
3	CTR\150C\36	0.010	0.012	10	In Favor Of Parent
4	CTR\150C\44	0.010	0.011	11	In Favor Of Parent
5	CTR\150C\60	0.014	0.01	-37	In Favor Of Daughter
6	CTR\150C\61	0.013	0.013	06	In Favor Of Parent

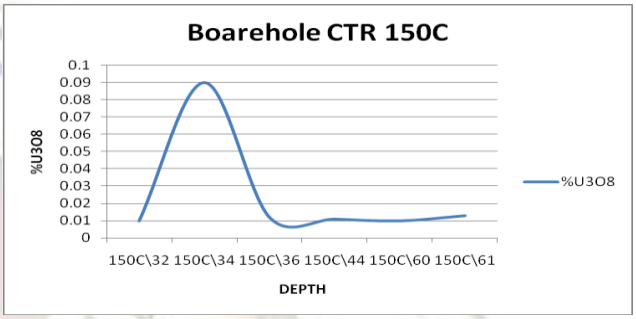

Figure 5: Graph between $\%U_3O_8$ Vs Sample Depth

4.5 SAMPLE DETAILS

- **Total number of samples** : 6
- **No. of borehole** : CTR-323C
- **Area** : Chitrial
- **Distract** : Nalgonda
- **State** : Andhra Pradesh
- **Nature of sample** : Borehole core Sample

Table 5: Average: 170% In favor of Daughter.

S.NO	SAMPLE NAME	$\%eU_3O_8$	$\%U_3O_8$	% d.f	INTERPRETATION
1	CTR\323C\2\10	0.016	0.015	-9	In Favor Of Daughter
2	CTR\323C\2\14	0.033	0.029	-12	In Favor Of Daughter
3	CTR\323C\2\15	0.010	0.051	-41	In Favor Of Daughter
4	CTR\323C\2\17	0.010	0.080	-18	In Favor Of Daughter
5	CTR\323C\2\18	0.08	0.042	-48	In Favor Of Daughter
6	CTR\323C\2\19	0.018	0.017	-42	In Favor Of Daughter

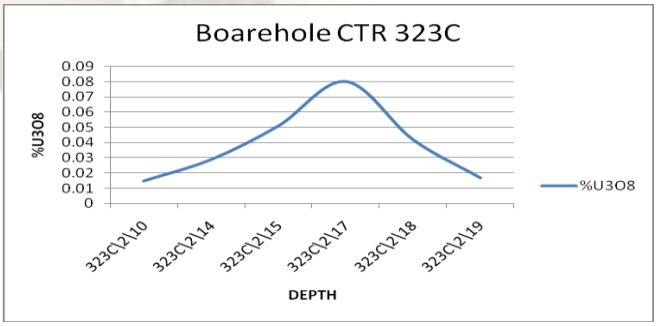

Figure 6: Graph between $\%U_3O_8$ Vs Sample Depth

4.6 TOTAL SAMPLES ANALYZED:

Radiometric Analysis data obtained using BETA GAMMA METHOD.

Table 6: Percentage of Disequilibrium

S.NO	SAMPLE NAME	U_T	U_3O_8	% OF DISEQUILIBRIUM
1	CTR\114\54.5-55.0	256	110	-57
2	CTR\114\55.0-55.5	3651	6805	86
3	CTR\114\55.5-56.0	599	995	66
4	CTR\150C\32 CTR\114\56.0-56.5	238	431	81
5	CTR\114\56.5-57.0	412	552	33
6	CTR\149C\B\2\13	88	68	-22
7	CTR\149C\2\5	104	56	-46
8	CTR\149C\2\6	77	90	16
9	CTR\149C\2\8	91	42	-53
10	CTR\149C\2\9	89	54	-39
11	CTR\149C\2\10	190	207	8
12	CTR\149C\2\11	205	220	7
13	CTR\149C\2\12	130	86	-33
14	CTR\149C\2\15	110	116	5
15	CTR\150C\31	112	131	16

Table 7: Percentage of Disequilibrium

16	CTR\150C\32	116	103	-11
17	CTR\150C\34	120	92	-23
18	CTR\150C\36	104	115	10
19	CTR\150C\44	97	108	11
20	CTR\150C\60	137	103	-11
21	CTR\150C\61	126	134	-24
22	CTR\160C\B\2\18	177	134	-24
23	CTR\160C\B\2\34	84	74	-11
24	CTR\160C\B\2\37	115	87	-24
25	CTR\160C\B\2\47	104	50	-51
26	CTR\160C\2\36	96	73	-23
27	CTR\160C\3\40	127	64.5	-48
28	CTR\160C\3\48	125	70	-44
29	CTR\160C\3\56	72	122	69
30	CTR\226C\B\7\16	740	1111	50
31	CTR\226C\B\7\25	930	743	-20

Table 8: Percentage of Disequilibrium

32	CTR\226C\7\17	1139	1341	18
33	CTR\303C\B\2\17	118	178	50
34	CTR\303C\2\12	81	81	0
35	CTR\303C\2\30	135	72	-46
36	CTR\303C\2\83	138	33	-76
37	CTR\303C\4\81	77	47	-38
38	CTR\303C\4\86	83	55	-33
39	CTR\303C\5\100	119	166.5	39
40	CTR\303C\5\102	198	83	-58
41	CTR\312C\2\18	351	521	48
42	CTR\312C\2\22	168	73	-56
43	CTR\312C\2\23	1602	1160	-27
44	CTR\312C\B\2\25	100	49	-51
45	CTR\312C\B\2\26	2436	2701	11
46	CTR\312C\B\2\27	183	188	3

Table 9: Percentage of Disequilibrium

47	CTR\312C\B\2\30	81	54	-33
48	CTR\323C\2\9	120	143	19
49	CTR\323C\2\10	161	146	-9
50	CTR\323C\2\14	333	293	-12
51	CTR\323C\2\15	101	51	-49
52	CTR\323C\2\17	98	80	-18
53	CTR\323C\2\19	185	107	-42
54	CTR\323C\B\2\10	156	148	-5
55	CTR\323C\B\2\14	334	301	-9
56	CTR\323C\B\2\20	122	114	-6
57	CTR\323C\B\2\30	81	54	-33
58	CTR\526C\B\10	190	119	-37
59	CTR\526C\B\7	308	182	-40
60	CTR\526C\13	350	314	-10

V. CONCLUSION

The present study of radiometric analysis of laboratory method BETA (β)/ GAMMA (γ) METHOD. In this work the BETA (β)/ GAMMA (γ) technique were applied to analyze the field samples from Chitrial area, Nalgonda district, and 61 samples were analyzed for BETA (β)/ GAMMA (γ) METHOD. For estimating the original content of eU_3O_8 using various disequilibrium, equilibrium standards. These above samples may be grouped as: a) sample in which the equivalent U_3O_8 value as measured in terms of the Gamma (γ) activity i.e. (eU_3O_8) Gamma (γ) came out to be equal to the Uranium content as given by equation, the Uranium series in such samples is in equilibrium and no Thorium is present ; b) samples in which the (eU_3O_8) Gamma(γ) is more then the Uranium content.; the sample is either out of equilibrium or Thorium is present or both but since eU_3O_8 is more then the Uranium content the disequilibrium would be of a type in which the Uranium group is deficient and as such material is not common unless a fresh leaching has taken place, the possibility that Thorium is present is more; c) samples in which (eU_3O_8) Gamma (γ) is less than the Uranium content, the sample is in a state of disequilibrium of the type in which the Uranium group is in excess and the possibility of the presence of Thorium is not much. This work of radiometric analysis of the rock samples is an inevitable part of Uranium exploration and the described in thesis will be useful in a variety of exploration, in addition to Uranium exploration.

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