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SIXTH REPORT ON PROJECT 970/RI/RB BY PRINCIPAL SCIENTIFIC INVESTIGATOR

Final Report By

(A.S.Bhatnagar)

Study of the Behaviour of Radon in Soil and Interpretation of the Anomaly in Exploration for Uranium

The present report covers the period from September 1973 to February 1974.

It has been brought out in earlier reports that the distribution of radon in soils fits into a lognormal pattern. In places where uranium mineralisation exists the distribution pattern is a two lognormal one. Thus if one carries out systematic radon measurements over an area the resulting distribution pattern can tell whether or not any uranium mineralisation occurs in the area.

In our fifth report we had discussed the possibility of delineating an area over which the influence of radon from a deposit is perceptible since it affects the single lognormal pattern normal of the area. From the work done at Udaisagar (Rajasthan) one can say that this method can be used to classify areas and delineate them according to the distribution pattern found over them. Those showing a two lognormal distribution would be the areas where further detailed exploration for uranium could be undertaken. Thus the method helps to cut down the amount of field work by reducing the size of the area to be investigated in detail.

It was also mentioned in the earlier report that a two lognormal distribution pattern arises from the mixing of two radon populations, one due to the distribution of radium in soil and the other due to migration of radon from a Uranium source. If, therefore, one is very close to a deposit the radon due to this source may dominate the radon due to soil and in such situations, single lognormal distribution can result. To visulise, as one approaches a near surface source (uranium deposit) one enters a zone characterised by a two lognormal pattern as one passes close to the deposit the pattern once again may

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change to single lognormal due to the radon from the source predominating over that present in the soil. As the traverse continues the pattern may change to a two lognormal one and once again to a single lognormal one, as one passes out of the zone of influence of migrating radon. This may be expected to be so whether one approaches the deposit along the surface or down the depth. Observations were taken at Udaisagar with increasing depth of auger holes and the distribution pattern obtained at various depths showed a charge which would seem to confirm the idea put forth above.

Uptil now radon studies were made over Delhi and Rajasthan areas to confirm that the results of these studies should generally hold irrespective of where the area lay, we chose an area called Turumdih in Bihar which is about 1000 miles north-east of Udaisagar (Rajasthan). Here drilling had shown the presence of a uranium deposit 20-100 meters below the surface. Here we found a Zone of single log normal distribution surrounded by a zone of two lognormal distribution. Checking on the drilling results it appeared that here the deposit had come closest to the surface such that radon migrating from it began to dominate over the radon component present in the surface soil.

Again if one takes measurements over a deposit at different depths it is possible that at certain depth the distribution pattern may change from a two lognormal one to a single lognormal one if the radon due to the source starts dominating the soil radon at that depth. To check this measurements were made at different depths in grid Y at Udaisagar. Here, for 90 cm and 150 cm deep auger holes a two lognormal distribution pattern was observed but when these holes were deepened to 270 cms the distribution pattern changed to a single lognormal distribution. This experiment clearly demonstrated that when the radon from a uranium source dominates over the radon from the soil, a single lognormal distribution pattern is observed.

FIELD WORK:

1. Delhi Area:

In the earlier report it was discussed that in Delhi

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area (N.P.L.) an old radioactive sample dump was located by radon measurements as in this area a two-lognormal normal pattern was obtained. This area was gridded and at every 5 meter interval, the behaviour of radon was studied and part of this work was reported in the fifth report. Further work in the Delhi area was undertaken with the object of comparing the detectability of the radon method with that of the scintillometer. 27 points on the grid were completed and the results are given in tables I - XXIII and the log probability plots are shown in Figs. 1 - 23. Plate I shows the grid location. Mark (/) indicates two-lognormal distribution and the mark (/) indicates one lognormal distribution. The continuous lines show the isorads as obtained with a scintillometer. It would appear from the diagram that the affect of the sample dump in terms of radon as indicated by the two lognormal distribution (/) is felt upto a much larger distance than would be detectable with a scintillometer and we can say that the radon method can 'sense' the uranium radioactivity from a much greater distance and is not restricted by the soil cover.

2. Turumdih:

As already mentioned this area is about 1000 miles north east of Udaisagar (Rajasthan) where most of the work reported has been carried out. A far off area was purposely chosen to confirm that the method is generally applicable and the results hold irrespective of where the area lay. The results are given in tables 28 - 42 and the figs. 28 -42 show the distribution pattern corresponding to each point of observation. Plate II shows the type of distribution as (/) or (/). The points marked TRG ix to xxii indicate the position of the drill holes on the grid adopted for exploratory drilling.

An interesting fact that emerges from the observations carried out at Turumdih is the appearance of single - lognormal distribution (marked ⊘ on the plate II) within an

extensive Zone of two - lognormal distribution which coincides with the position of the drill holes where diamond drilling had shown the deposit as having come closest to the surface (20 meters) and so is likely to have been caused by the radon emanating from the source dominating over that contained in the soil and due to the mineralised fragments in the composition of the soil. The appearance of such single lognormal distribution pattern within an extensive two lognormal pattern therefore would appear to acquire a significance and should deserve attention.

3. Udaisagar:

The time taken up by an observation in any survey or exploration method is an important factor in determining the usefulness and practicability of the method. An attempt was therefore made to see if this time could be reduced while suggesting radon method as an exploratory method. In our experimental work the radon sample was taken from a depth of 90 cam. in the auger hole. This was then allowed to stand for 4 hours for equilibrium to be established.

Having confirmed these conclusions, attempt was made to see if this work could be speeded up. Two time is taken, first in making 90 cm holes for drawing a radon sample which is then allowed to stand for 4 hours for equilibrium to be established. To speed up the field observations one has to see if any of these times can be reduced without affecting the results. Since making holes upto 90 cm depth takes time, we decided to experiment on 60 cm deep auger holes. These trials were made at Udaisagar and it was found that the distribution is seriously affected if the augerholes' depth is reduced to 60 cm. This was, therefore abondoned. In 90 cm deep holes measurements were made after waiting for 5 mts. and then after 4 hours. It was found that the distribution pattern did not change in the two cases. It is, therefore, suggested that observations could be taken after 5 minutes instead of 4 hours after pumping thereby increasing the number of sampling points in a day. The results are given in Tables 24-27 and figures 24-27.

TABLE I: Frequency distribution of radon values at Delhi: Location (5 S, 10 E).

*****

Class Interval in Counts/min.	Frequency	Cum-Frequency	%Cum-Frequency
20 - 60	17	17	32
60 - 100	5	22	37.5
100 - 140	6	28	50
140 - 180	5	33	59
180 - 220	6	39	67.7
220 - 260	5	44	78.6
260 - 300	2	46	82.3
300 - 340	3	49	87.5
340 - 380	5	54	96.5
380 - 420	2	56	100

TABLE II: Frequency distribution of radon values at Delhi: Location (5 S, 15 E).

.....

Class Interval in Counts/mt.	Frequency	Cum-Frequency	%Cum-Frequency
35 - 55	1	1	1.07
55 - 75	1	2	2.2
75 - 95	1	3	3.2
95 - 115	3	6	6.5
115 - 135	4	10	10.7
135 - 155	11	21	22.6
155 - 175	15	36	38.7
175 - 195	23	59	63.4
195 - 215	19	78	83.8
215 - 235	12	90	96.6
235 - 255	2	92	99.0
255 - 275	1	93	100

Table III: Frequency distribution of radon values at Delhi: Location (5 S, 20 E).

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Class Interval in Counts/mt.	Frequency	Cum-Frequency	%Cum-Frequency
20 - 40	7	7	8.2
40 - 60	2	9	10.5
60 - 80	1	10	11.6
80 - 100	5	15	17.4
100 - 120	14	29	33.7
120 - 140	22	51	59.3
140 - 160	20	71	82.5
160 - 180	12	83	96.5
180 - 200	3	86	100

TABLE IV: Frequency distribution of radon values at Delhi: Location (5 S, 25 E).

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Class Interval in Counts/m³	Frequency	Cum-Frequency	%Cum-Frequency
120 - 130	3	3	5
130 - 140	6	9	22
140 - 150	10	19	32.4
150 - 160	7	26	44
160 - 170	4	30	51
170 - 180	3	33	56
180 - 190	7	40	68
190 - 200	6	46	78
200 - 210	6	52	88
210 - 220	6	58	98.6
220 - 230	1	59	100

TABLE V: Frequency distribution of radon values at Delhi Location (10 S, 103).

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Class Interval in Counts/mt.	Frequency	Cum-Frequency	%Cum-Frequency
15 - 45	11	11	18.5
45 - 75	12	23	35.4
75 - 105	4	27	41.6
105 - 135	3	30	46.2
135 - 165	8	38	58.5
165 - 195	7	45	69.3
195 - 225	8	53	81.7
225 - 255	5	58	89.4
255 - 285	1	59	90.8
285 - 315	3	62	95.5
315 - 345	1	63	97
345 - 375	1	64	98.5
375 - 405	1	65	100

TABLE VI: Frequency distribution of radon values at Delhi: Location (10S, 15E).

Class Interval in Counts/mt.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 30	19	19	28.4
30 - 60	19	38	56.7
60 - 90	5	43	64.3
90 - 120	5	48	71.7
120 - 150	6	54	80.7
150 - 180	2	56	83.6
180 - 210	7	63	94.0
210 - 240	1	64	95.5
240 - 270	2	66	98.5
270 - 330	2	66	98.5
330 - 360	1	67	100

TABLE VII: Frequency distribution of radon values at Delhi: Location: (108, 203).

Class Interval in Count/Mt.	Frequency	Cum-Frequency	%Cum-Frequency
10 - 30	3	3	4.3
30 - 50	11	14	20.0
50- 70	16	30	42.8
70 - 90	13	43	61.3
90 - 110	4	47	67.2
110 - 130	8	55	78.7
130 - 150	7	62	88.6
150 - 170	2	64	91.4
170 - 190	4	68	97.2
190 - 210	0	68	97.2
210 - 230	1	69	98.5
230 - 250	1	70	100

TABLE VIII: Frequency distribution of radon values at Delhi: Location (10S, 25E).

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Class Interval in Count/Hr.	Frequency	Cum-Frequency	%Cum-Frequency
10 - 40	8	8	11.9
40 - 70	8	16	23.8
70 - 100	4	20	29.8
100 - 130	6	26	38.8
130 - 160	5	31	46.3
160 - 190	10	41	61.3
190 - 220	16	57	85.2
220 - 250	6	63	94.0
250 - 280	3	66	98.5
280 - 310	1	67	100

TABLE IX: Frequency distribution of radon values at Delhi: Location (28S, 30E).

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Class Interval in Count/mt.	Frequency	Cum-Frequency	%Cum Frequency
30 - 50	1	1	0.8
50 - 70	1	2	1.7
70 - 90	6	8	6.7
90 - 110	10	18	15.2
110 - 130	11	29	24.4
130 - 150	22	51	42.8
150 - 170	33	84	70.7
170 - 190	24	108	90.8
190 - 210	11	119	100

TABLE 1: Frequency distribution of radon values at Delhi: Location (10S, 35E).

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Class Interval In Counts/Hr.	Frequency	Cum-Frequency	%Cum-Frequency
60 - 70	3	3	4.3
70 - 80	2	5	7.2
80 - 90	6	11	15.9
90 - 100	4	15	21.7
100 - 110	13	28	40.6
110 - 120	7	35	50.7
120 - 130	11	46	66.7
130 - 140	9	55	79.7
140 - 150	5	60	87.0
150 - 160	6	66	95.7
160 - 170	1	67	97.1
170 - 180	1	68	98.5
180 - 190	1	69	100

such situations, single lognormal distribution can [illegible]
To visulise, as one approaches a near surface source (uranium deposit) one enters a zone characterised by a two lognormal pattern as one passes close to the deposit the pattern once again may

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TABLE XI: Frequency distribution of radon values at Delhi: Location (15S, 10E).

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Class Interval in Counts/Hr.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 20	22	22	36.6
20 - 40	4	26	43.3
40 - 60	5	31	51.7
60 - 80	8	39	65.0
80 - 100	10	49	81.6
100 - 120	7	56	93.3
120 - 140	4	60	100

TABLE XII: Frequency distribution of radon values at Delhi Location (15S, 15E).

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Class Interval in Counts/Hr.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 20	33	33	41.2
20 - 40	14	47	58.7
40 - 60	7	54	67.5
60 - 80	16	70	87.5
80 - 100	7	77	96.2
100 - 120	2	79	98.8
120 - 140	1	80	100

bution pattern is observed.

FIELD WORK:

1. Delhi Area:

In the earlier report it was discussed that in Delhi -/-

TABLE XIII: Frequency distribution of radon values at Delhi Location: (15S, 30E).

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Class Interval in Counts/min.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 20	42	42	50.0
20 - 40	9	51	60.7
40 - 60	13	64	76.2
60 - 80	6	70	83.3
80 - 100	7	77	91.6
100 - 120	4	81	96.4
120 - 140	1	82	97.6
140 - 160	1	83	98.8
160 - 180	0	83	98.8
180 - 200	1	84	100

TABLE XIV: Frequency distribution of radon values at Delhi: Location (20S, 5E).

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Class Interval in Counts/min.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 20	5	5	5.6
20 - 40	17	22	24.6
40 - 60	24	46	51.5
60 - 80	22	68	76.2
80 - 100	12	80	89.6
100 - 120	8	88	98.6
120 - 140	1	89	99-7
140 - 160	1	90	100

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distribution (marked) on the place [illegible]

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TABLE XV: Frequency distribution of radon values at Delhi. Location (20S, 15E).

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Class Interval in Counts/Mt.	Frequency	Cum-Frequency	%Cum-Frequency
20 - 40	10	10	11.3
40 - 60	16	26	29.3
60 - 80	14	40	45.0
80 - 100	28	68	76.5
100 - 120	14	82	92.3
120 - 140	2	84	94.5
140 - 160	3	87	97.8
160 - 180	2	89	100

TABLE XVI: Frequency distribution of radon values at Delhi: Location (20S, 25E).

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Class Interval in Counts/Mt.	Frequency	Cum-Frequency	%Cum-Frequency
5 - 15	9	9	13.8
15 - 25	11	20	30.7
25 - 35	8	28	43.1
35 - 45	13	41	62.1
45 - 55	7	48	73.8
55 - 65	10	58	89.3
65 - 75	4	62	95.3
75 - 85	2	64	98.5
85 - 95	0	64	98.5
95 -105	1	65	100

be taken after 5 minutes instead of 4 hours after pumping thereby increasing the number of sampling points in a day. The results are given in Tables 24-27 and figures 24-27.

TABLE XVII: Frequency distribution of radon values at Delhi: Location (20S, 35E).

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Class Interval in Counts/ml.	Frequency	Cum-Frequency	%Cum-Frequency
10 - 20	10	10	9.5
20 - 30	13	23	21.8
30 - 40	17	40	38.0
40 - 50	13	53	50.4
50 - 60	10	63	60.8
60 - 70	7	70	67.2
70 - 80	7	77	73.3
80 - 90	5	82	78.0
90 - 110	4	86	81.9
110 - 130	7	93	88.5
130 - 150	7	100	95.2
150 - 170	2	102	97.0
170 - 190	2	104	99.0
190 - 210	1	105	100

TABLE XVIII: Frequency distribution of radon values at Delhi. Location (25S, 10E).

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Class Interval in Counts/ml.	Frequency	Cum-Frequency	%Cum-Frequency
50 - 70	2	2	3.3
70 - 90	6	8	13.4
90 - 110	18	26	43.4
110 - 130	12	38	63.5
130 - 150	9	47	78.5
150 - 170	8	55	91.8
170 - 190	5	60	100

TABLE XIX: Frequency distribution of radon values at Delhi. Location (25S, 20E).

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Class Interval in Counts/mt.	Frequency	Cum-Frequency	%Cum-Frequency
10 - 30	1	1	1
30 - 50	1	2	2
50 - 70	4	6	6
70 - 90	10	16	16
90 - 110	11	27	27
110 - 130	18	45	45
130 - 150	22	67	67
150 - 170	15	82	82
170 - 190	11	93	93
190 - 210	6	99	99
210 - 230	1	100	100

TABLE XX: Frequency distribution of radon values at Delhi: Location (30S, 5E).

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Class Interval in Counts/mt.	Frequency	Cum-Frequency	%Cum-Frequency
10 - 20	6	6	8.7
20 - 30	5	11	15.9
30 - 40	11	22	31.8
40 - 50	12	34	49.3
50 - 60	10	44	63.7
60 - 70	12	56	81.2
70 - 80	8	64	92.7
80 - 90	2	66	95.6
90 - 100	1	67	97.1
100 - 110	0	67	97.1
110 - 120	2	69	100

TABLE XXI: Frequency distribution of radon values at Delhi: Location (30S, 15S).

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Class Interval in Counts/Hr.	Frequency	Cum-Frequency	%Cum-Frequency
30 - 60	5	5	6.3
60 - 90	1	6	7.5
90 - 120	2	8	10.0
120 - 150	5	13	16.2
150 - 180	4	17	21.2
180 - 210	4	21	26.2
210 - 240	9	30	38.5
240 - 270	12	42	52.5
270 - 300	20	62	72.5
300 - 330	10	72	90.0
330 - 360	2	74	92.5
360 - 390	2	76	95.0
390 - 420	3	79	98.3
420 - 450	0	79	98.3
450 - 480	1	80	100

TABLE XXII: Frequency distribution of radon values at Delhi: Location: (30S, 25E).

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Class Interval in Counts/mt.	Frequency	CumFrequency	%Cum-Frequency
15 - 35	3	3	4.8
35 - 55	2	5	7.2
55 - 75	3	8	11.4
75 - 95	2	10	14.3
95 - 115	2	12	17.1
115 - 135	7	19	27.1
135 - 165	10	29	41.4
165 - 195	19	48	67.2
195 - 225	7	55	78.6
225 - 255	8	63	90.0
255 - 285	3	66	94.3
285 - 315	0	66	94.3
315- 345	3	69	98.5
345 - 375	1	70	100

TABLE XXIII: Frequency distribution of radon values at Delhi: Location (30S, 35E).

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Class Interval in Counts/Hr.	Frequency	Cum-Frequency	%Cum-Frequency
10 - 40	2	2	2.9
40 - 70	6	8	11.9
70 - 100	8	16	26.9
100 - 130	6	22	32.8
130 - 160	9	31	41.5
160 - 170	2	33	49.3
170 - 180	5	38	56.7
180 - 190	6	44	65.7
190 - 200	6	50	74.7
200 - 210	4	54	80.6
210 - 220	1	55	82.2
220 - 230	3	58	86.7
230 - 240	2	60	89.6
240 - 250	4	64	95.5
250 - 260	1	65	97.0
260 - 270	2	67	100

TABLE XXIV: Frequency distribution of radon values at Udaisagar(Grid Y): 60 cm. deep holes and counting taken 5 mts. after pumping.

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Class Interval in Counts/mt.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 100	35	35	50.7
100 - 200	7	42	60.9
200 - 300	7	49	71.0
300 - 400	4	53	76.8
400 - 500	10	63	91.3
500 - 600	2	65	94.2
600 - 700	1	66	95.7
700 - 800	1	67	97.1
800 - 1000	0	67	97.1
1000 - 1100	1	68	98.5
1100 - 1200	0	68	98.5
1200 - 1300	1	69	100

TABLE XXV: Frequency distribution of radon values at Udaisagar (Grid Y): 60 cm. deep holes counting taken 4 hours after pumping.

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Class Interval in Counts/Mt.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 100	20	20	28.9
100 - 200	17	37	53.6
200 - 300	2	39	56.5
300 - 400	8	47	68.1
400 - 500	2	49	71.0
500 - 600	4	53	76.8
600 - 700	0	53	76.8
700 - 800	5	58	84.1
800 - 900	7	65	94.2
900 - 1000	1	66	95.6
1000 - 1300	0	66	95.6
1300 - 1400	1	67	97.1
1400 - 1800	0	67	97.1
1800 - 1900	1	68	98.5
1900 - 2000	0	68	98.5
2000 - 2100	1	69	100

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TABLE XXVI: Frequency distribution of radon values at Udaisagar(Grid Y): 90 cm. deep holes counting taken 5 mts. after pumping.

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Class Interval in Counts/mt.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 100	2	2	2.9
100 - 200	24	26	38.8
200 - 300	14	40	59.7
300 - 400	10	50	74.6
400 - 500	5	55	82.1
500 - 600	5	60	89.6
600 - 700	3	63	94.0
700 - 800	1	64	95.5
800 - 1200	0	64	95.5
1200 - 1300	1	65	97.0
1300 - 1400	1	66	98.5
1400 - 1500	1	67	100

TABLE XXVII: Frequency distribution of radon values at Udaisagar(Grid Y): 90 cm. deep holes counting taken 4 hours after pumping.

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Class Interval in Counts/mt.	Frequency	Cum-Frequency	%Cum-Frequency
100 - 200	6	6	8.9
200 - 300	18	24	35.8
300 - 400	11	35	52.2
400 - 500	4	39	58.2
500 - 600	9	48	71.6
600 - 700	5	53	79.1
700 - 800	2	55	82.1
800 - 900	2	57	85.1
900 - 1000	2	59	88.1
1000 - 1100	4	63	94.0
1100 - 1200	0	63	94.0
1200 - 1300	1	64	95.5
1300 - 2100	0	64	95.5
2100 - 2200	1	65	97.0
2200 - 2300	1	66	98.5
2300 - 2400	0	66	98.5
2400 - 2500	1	67	100

TABLE XXVIII: Frequency distribution of radon values at Turamdih: (THOIX).

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Class Interval in Counts/Hr.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 100	23	23	23.4
100 - 200	13	36	36.9
200 - 300	3	39	39.8
300 - 400	12	51	52
400 - 500	6	57	58.2
500 - 600	5	62	63.2
600 - 700	7	69	70.5
700 - 800	8	77	78.5
800 - 900	3	80	81.6
900 - 1000	8	88	90.0
1000 - 1100	3	91	93.0
1100 - 1200	2	93	95.0
1200 - 1300	2	95	97.0

TABLE XXIX: Frequency distribution of radon values at Turamdih(THG X)

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Class Interval in counts/mb.	Frequency	Cum-Frequency	%Cum-Frequency
0 - 100	14	14	14
100 - 200	8	22	22
200 - 300	10	32	32
30 - 400	12	44	44
400 - 500	12	56	56
500 - 600	6	62	62
600 - 700	8	70	70
700 - 800	8	78	78
800 - 900	5	83	83
900 - 1000	5	88	88
1000 - 1100	2	90	90
1100 - 1200	4	94	94
1200 - 1300	2	96	96
2800 - 2900	1	97	97
2900 - 3000	1	98	98
3300 - 3400	1	99	99
3600 - 3700	1	100	100

TABLE XXXI Frequency distribution of radon values at Turamdih(TAG IA)

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Class Interval in counts/m³.	Frequency	Cum-Frequency	%Cum-Frequency
100 - 200	2	2	2.33
200 - 300	9	11	12.8
300 - 400	2	13	15.1
400 - 500	3	16	18.6
500 - 600	4	20	23.25
600 - 700	4	24	27.96
700 - 800	5	29	34
800 - 900	4	33	38.5
900 - 1000	5	38	44.2
1000 - 1100	2	40	46.5
1200 - 1300	3	43	50
1300 - 1400	2	45	52.3
1400 - 1500	4	49	57
1500 - 1600	4	53	61.6
1600 - 1700	1	54	63
1700 - 1800	4	58	67.4
1800 - 1900	5	63	72
1900 - 2000	7	70	81.4
2000 - 2100	7	77	89.5
2100 - 2200	4	81	94.2
2200 - 2300	1	82	95.3
2300 - 2400	3	85	98.8
2600 - 2700	1	86	100

140 - 160	1	90	100

TABLE XXXI: Frequency distribution of radon values at Turamdih(TRG XI)

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Class Interval in Counts/Hr.	Frequency	Cum-Frequency	%Cum-Frequency
500 - 600	4	4	4.7
600 - 700	3	7	8.24
700 - 800	5	12	14.1
800 - 900	3	15	17.6
900 - 1000	4	19	22.3
1000 - 1100	4	23	27.1
1100 - 1200	10	33	38.9
1200 - 1300	8	41	48.3
1300 - 1400	8	49	57.7
1400 - 1500	8	57	67
1500 - 1600	9	66	77.6
1600 - 1700	2	68	80
1700 - 1800	5	73	86
1800 - 1900	3	76	89.5
1900 - 2000	3	79	93
2000 - 2100	1	80	94
2100 - 2200	2	82	96.5
2200 - 2300	1	83	97.6
2300 - 2400	1	84	99
2400 - 2500	1	85	100

95 -105	1	65	100

TABLE XXXII: Frequency Distribution of radon values at Turamdih (TRU XII).

Class Interval in Counts/mt.	Frequency	Cum-Frequency	% Cum-Frequency
100 - 200	1	1	1.0
200 - 300	2	3	3.0
300 - 400	3	6	6.1
400 - 500	0	6	6.1
500 - 600	1	7	7.2
600 - 700	3	10	10.2
700 - 800	4	14	14.3
800 - 900	4	18	18.4
900 - 1000	4	22	22.4
1000 - 1100	3	25	25.5
1100 - 1200	5	30	30.6
1200 - 1300	7	37	37.7
1300 - 1400	6	43	43.9
1400 - 1500	12	55	56.1
1500 - 1600	5	60	61.1
1600 - 1700	4	64	64.3
1700 - 1800	6	70	71.5
1800 - 1900	6	76	77.5
1900 - 2000	7	83	84.6
2000 - 2100	4	87	88.7
2100 - 2200	2	89	90.8
2200 - 2300	1	90	91.9

150 - 170	6	55	91.8
170 - 190	5	60	100

TABLE XXXIII: Frequency Distribution of radon values at Turamdih (TMG XIII)

Class Interval in Counts/min.	Frequency	Cum-Frequency	% Cum-Frequency
600 - 800	3	3	3.4
800 - 1000	5	8	9.0
1000 - 1200	14	22	24.7
1200 - 1400	8	30	33.6
1400 - 1600	4	34	38.2
1600 - 1800	9	43	48.5
1800 - 2000	8	51	57.5
2000 - 2200	8	59	66.2
2200 - 2400	11	70	78.5
2400 - 2600	1	71	80.0
2600 - 2800	4	75	84.5
2800 - 3000	11	86	97.0
3000 - 3200	2	88	99.00
3200 - 3400	0	88	99.0
3400 - 3600	1	89	100.0

100 - 110	0	67	97.1
110 - 120	2	69	100

TABLE XXXIV. Frequency Distribution of radon values at Turendih (TRG XIV).

Class Interval in counts/sq.	Frequency	Cum-Frequency	% Cum-Frequency
100 - 200	12	12	12
200 - 300	11	23	23
300 - 400	4	27	27
400 - 500	7	34	34
500 - 600	12	46	46
600 - 700	11	57	57
700 - 800	7	64	64
800 - 900	13	77	77
900 - 1000	4	81	81
1000 - 1100	10	91	91
1100 - 1200	8	99	99
1200 - 1300	1	100	100

TABLE XXXV: Frequency distribution of radon values at Turamdih (TNU/lit)

Class Interval in count/ml.	Frequency	Cum-Frequency	% Cum-Frequency
200 - 300	2	2	2.6
300 - 400	4	6	7.7
400 - 500	8	14	18.0
500 - 600	8	22	28.2
600 - 700	4	26	33.4
700 - 800	6	32	41.2
800 - 900	4	36	46.3
900 - 1000	3	39	50.2
1000 - 1100	2	41	52.7
1100 - 1200	5	46	59.2
1200 - 1300	7	53	68.1
1300 - 1400	8	61	78.5
1400 - 1500	3	64	82.0
1500 - 1600	5	69	88.5
1600 - 1700	4	73	94.00
1700 - 1800	3	76	97.5
1900 - 2000	1	77	100.0

Table XXXVI. Frequency distribution of radon values at Turumdih (Tal XVI)

Class Interval in counts/mt.	Frequency	Cum-Frequency	% Cum-Frequency
600 - 700	1	1	1.25
700 - 800	1	2	2.5
800 - 900	10	12	15.0
900 - 1000	3	15	18.8
1000 - 1100	5	20	25
1100 - 1200	9	29	36
1200 - 1300	9	38	47.5
1300 - 1400	15	53	66.2
1400 - 1500	7	60	75.0
1500 - 1600	8	68	85
1600 - 1700	4	72	90.0
1700 - 1800	1	73	91.2
1800 - 1900	2	75	93.8
1900 - 2000	2	77	96.2
2000 - 2100	3	80	100.0

TABLE XXXVIII: Frequency distribution of radon values at Turandih(TRG/XVII).

Class Interval in Counts/Mt.	Frequency	Cum.Frequency	% Cum-Frequency
0 - 100	2	2	2.2
100 - 200	2	4	4.5
200 - 300	4	8	9.0
300 - 400	7	15	16.75
400 - 500	13	23	31.5
500 - 600	14	42	47.2
600 - 700	4	46	51.7
700 - 800	9	55	61.8
800 - 900	6	61	68.6
900 - 1000	7	68	76.5
1000 - 1100	3	73	82.0
1100 - 1200	6	79	89.0
1200 - 1300	4	83	93.4
1300 - 1400	2	85	95.5
1400 - 1500	2	87.	97.6
1500 - 1600	1	88	99.0
1600 - 1700	1	89	100.0

TABLE XXXVIII: Frequency distribution of radon values at Turamdih(TRG/XVIII).

Class Interval in Counts/ml.	Frequency	Cum-Frequency	% Cum-Frequency
0 - 200	2	2	2.4
200 - 400	3	5	5.9
400 - 600	9	14	16.7
600 - 800	8	22	26.2
800 - 1000	21	43	51.2
1000 - 1200	10	53	63.2
1200 - 1400	9	62	73.9
1400 - 1600	9	71	84.5
1600 - 1800	9	80	95.3
1800 - 2000	2	82	97.6
2000 - 2200	1	83	99.0
3200 - 3400	1	84	100.0

Table XXXIX: Frequency distribution of radon values at Turemdth (TRG/LIX).

Class Interval in Counts/mt.	Frequency	Cum-Frequency	% Cum-Frequency
100 - 200	3	3	3.8
200 - 300	15	18	23.0
300 - 400	2	20	25.6
400 - 500	19	39	49.9
500 - 600	14	53	67.8
600 - 700	6	59	75.5
700 - 800	7	66	84.5
800 - 900	3	69	88.3
900 - 1000	4	73	93.4
1000 - 1100	3	76	97.3
1100 - 1200	2	78	99.9

Table XIa. Frequency distribution of radon values at Turamdih (TRO/XI)

Class Interval in Counts/mb.	Frequency	Cum-Frequency	% Cum-Frequency
50 - 100	14	14	17.5
100 - 150	7	21	26.3
150 - 200	5	26	32.5
200 - 250	11	37	46.2
250 - 300	6	43	53.8
300 - 350	7	50	62.5
350 - 400	5	55	68.8
400 - 450	9	64	80.0
450 - 500	5	69	86.2
500 - 550	2	71	88.8
550 - 600	4	75	93.8
600 - 650	1	76	95.00

TABLE XLI:- Frequency distribution of radon values at Turamdih (TRG/BKI).

Class Interval in Counts/mt.	Frequency	Cum-Frequency	% Cum-Frequency
200 - 300	2	2	2.2
300 - 400	15	17	18.9
400 - 500	13	30	33.3
500 - 600	19	49	54.4
600 - 700	9	58	64.4
700 - 800	6	64	71
800 - 900	4	68	75.5
900 - 1000	2	70	77.7
1000 - 1100	8	78	86.6
1100 - 1200	4	82	91.0
1200 - 1300	3	85	94.3
1300 - 1400	2	87	96.6
1400 - 1500	2	89	98.8
1500 - 1600	1	90	100.0

TABLE XLII: Frequency distribution of radon values at Turamdih (TRG/XXII)

Class Interval in Counts/Mt.	Frequency	Cum-Frequency	% Cum-Frequency
0 - 300	1	1	1
300 - 600	11	12	12.3
600 - 900	36	48	49.4
900 - 1200	13	61	62.8
1200 - 1500	15	76	78.3
1500 - 1800	7	83	85.5
1800 - 2100	3	86	88.6
2100 - 2400	1	87	89.6
2400 - 2700	1	88	90.6
2700 - 3000	2	90	92.6
3000 - 3300	0	90	92.6
3300 - 3600	4	94	96.8
3600 - 3900	0	94	96.8
3900 - 4200	1	95	97.8
4200 - 4500	1	96	98.9
4500 - 4800	1	97	100.0

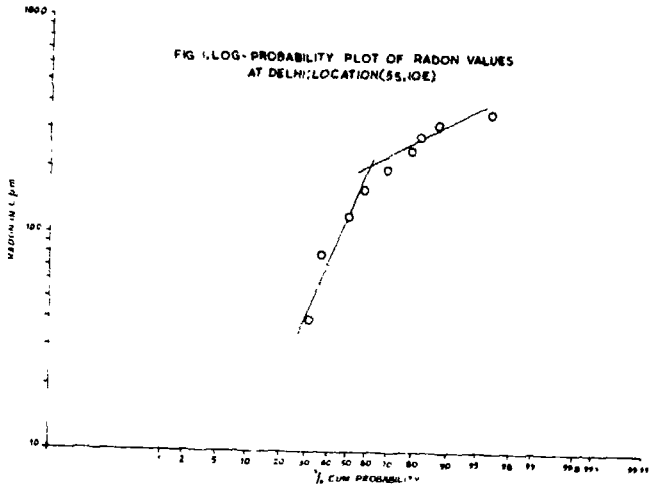

FIG 1. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI: LOCATION(5S, 10E)

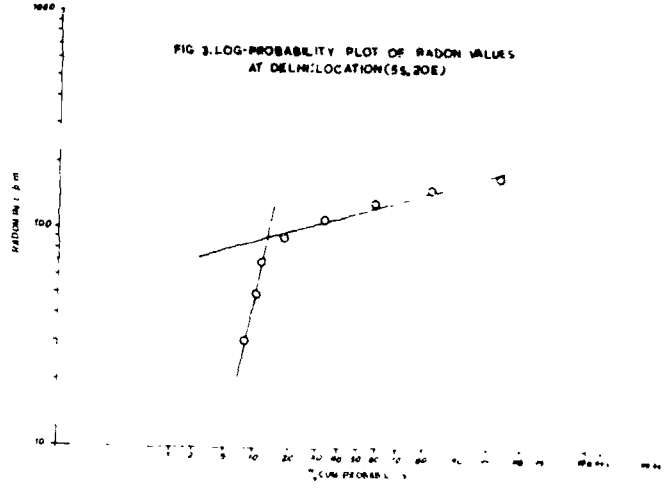

FIG 3. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI: LOCATION(5S, 20E)

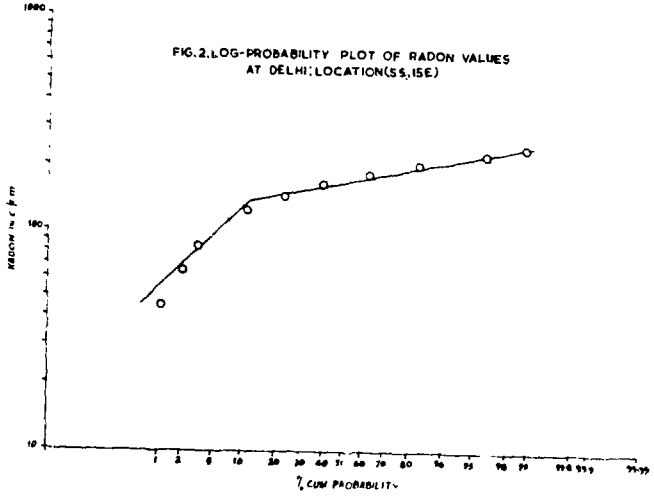

FIG. 2. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI: LOCATION(5S, 15E)

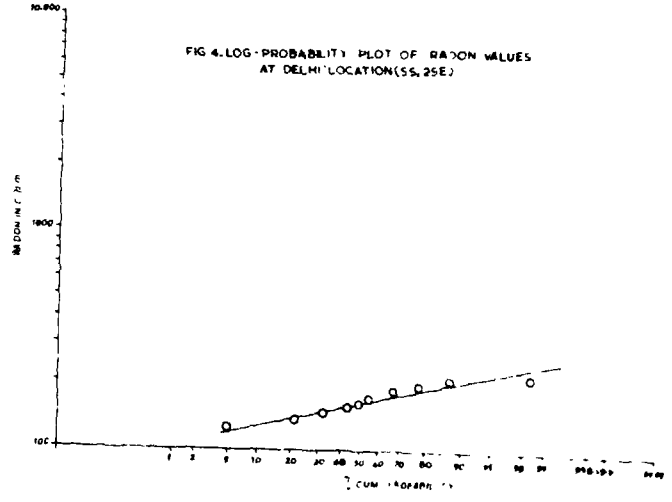

FIG 4. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI: LOCATION(5S, 25E)

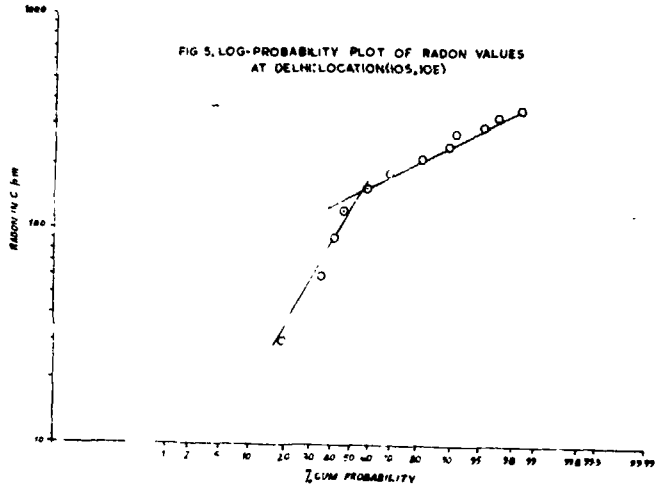

FIG 5. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI: LOCATION(10S, 10E)

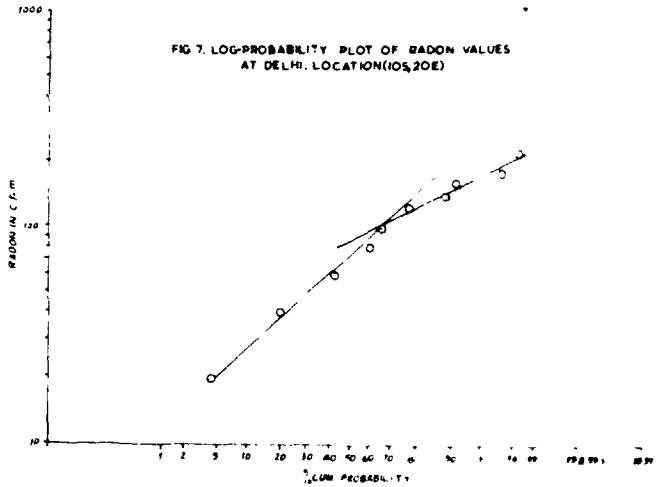

FIG 7. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI. LOCATION(10S, 20E)

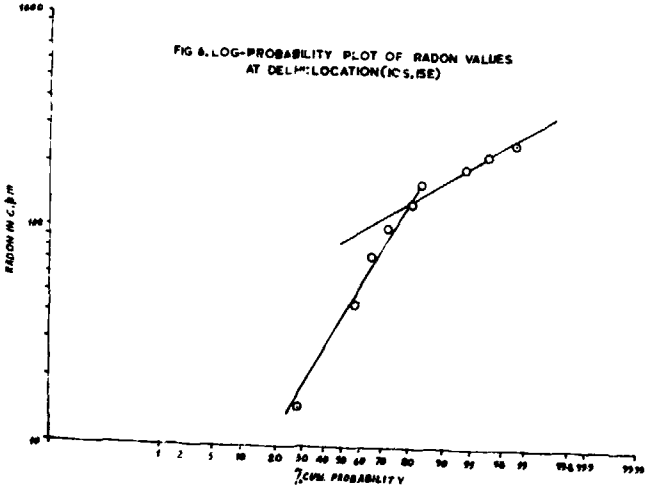

FIG 6. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI: LOCATION(10S, 15E)

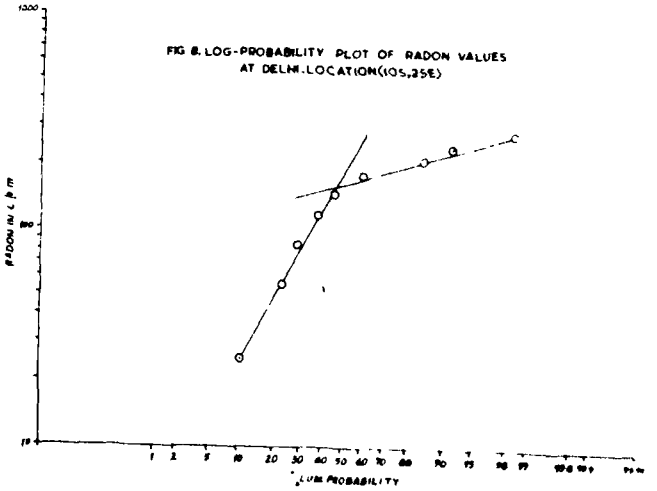

FIG 8. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI. LOCATION(10S, 25E)

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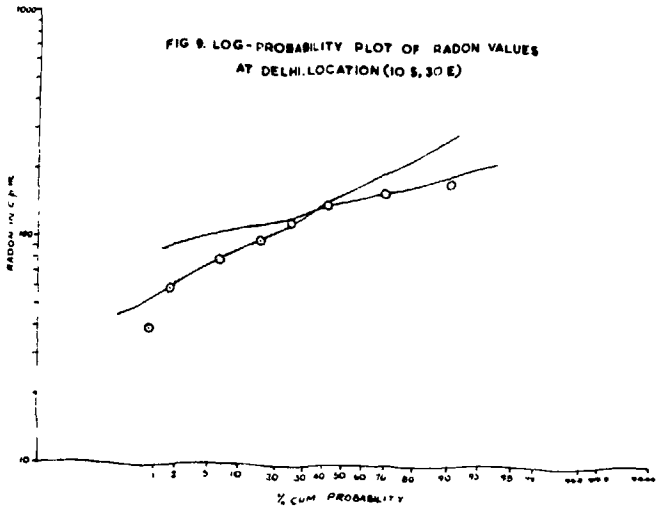


FIG 9. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI LOCATION (10 S, 30 E)

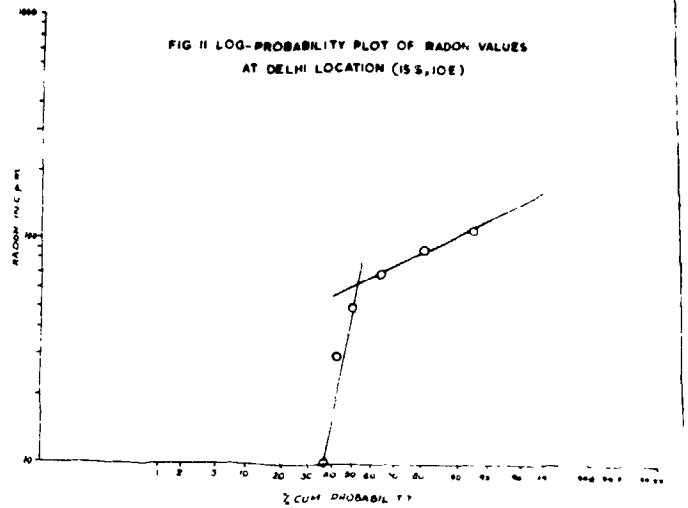


FIG 11 LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI LOCATION (15 S, 10 E)

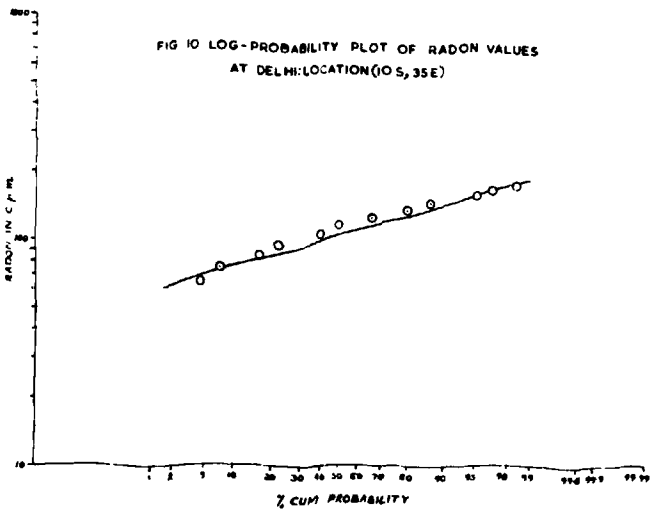


FIG 10 LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI LOCATION (10 S, 35 E)

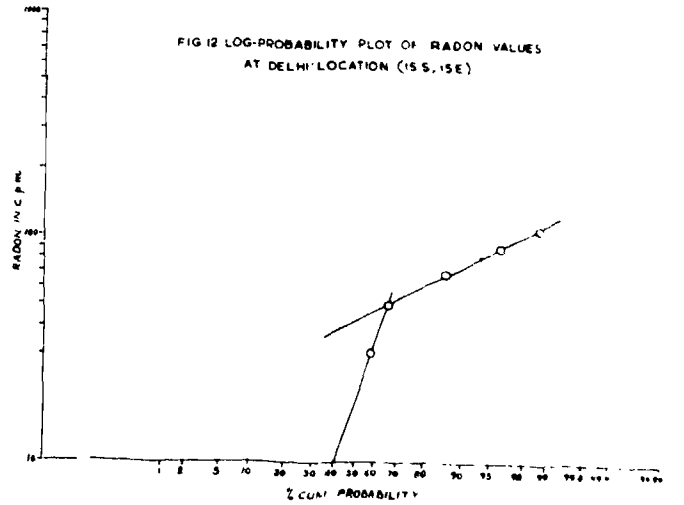


FIG 12 LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI LOCATION (15 S, 15 E)

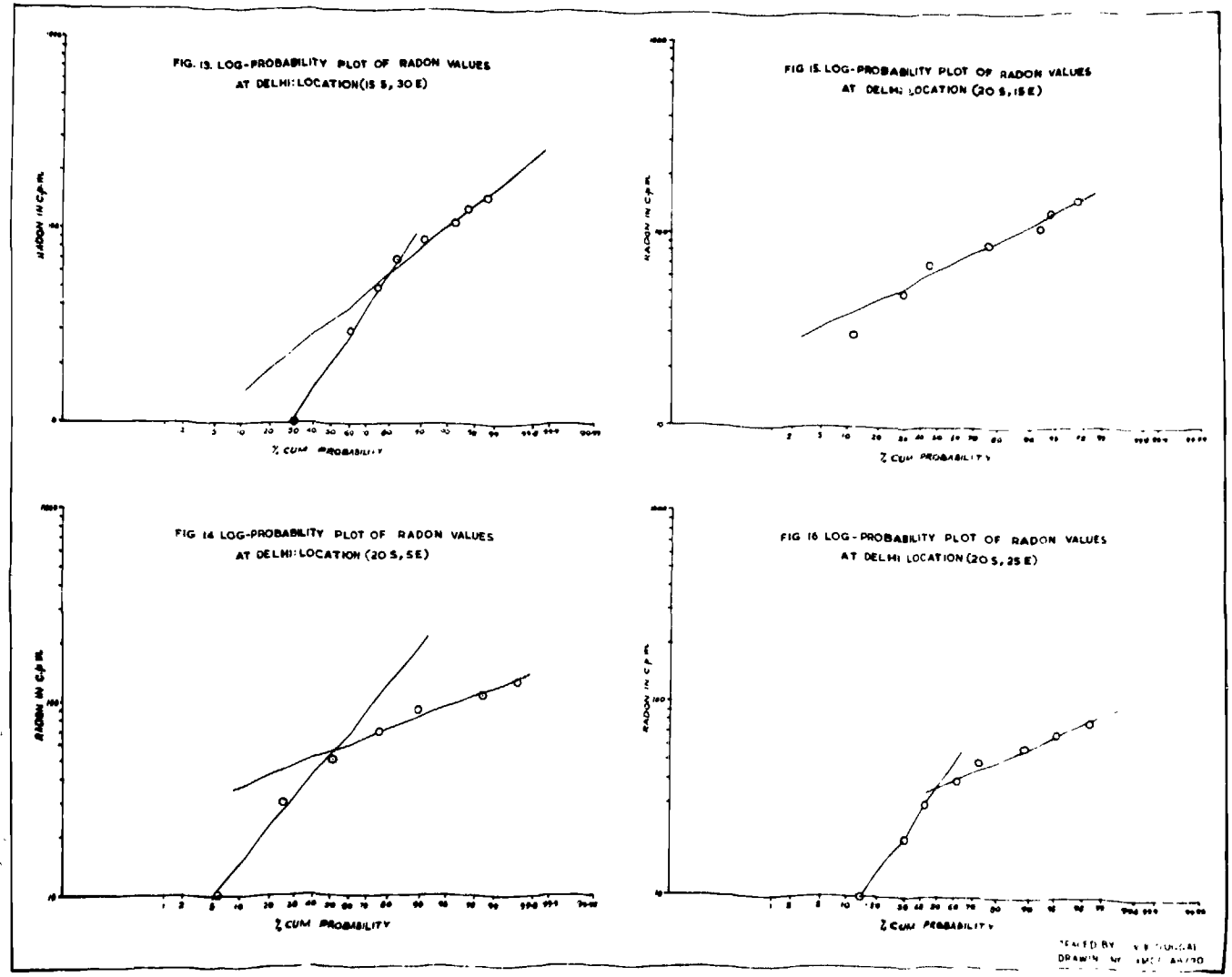


FIG. 13. LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI: LOCATION(15 S, 30 E)
RADON IN C.P.M.
% CUM PROBABILITY
FIG 15 LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI LOCATION (20 S, 15 E)
RADON IN C.P.M.
% CUM PROBABILITY
FIG 14 LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI: LOCATION (20 S, 5 E)
RADON IN C.P.M.
% CUM PROBABILITY
FIG 16 LOG-PROBABILITY PLOT OF RADON VALUES AT DELHI LOCATION (20 S, 25 E)
RADON IN C.P.M.
% CUM PROBABILITY

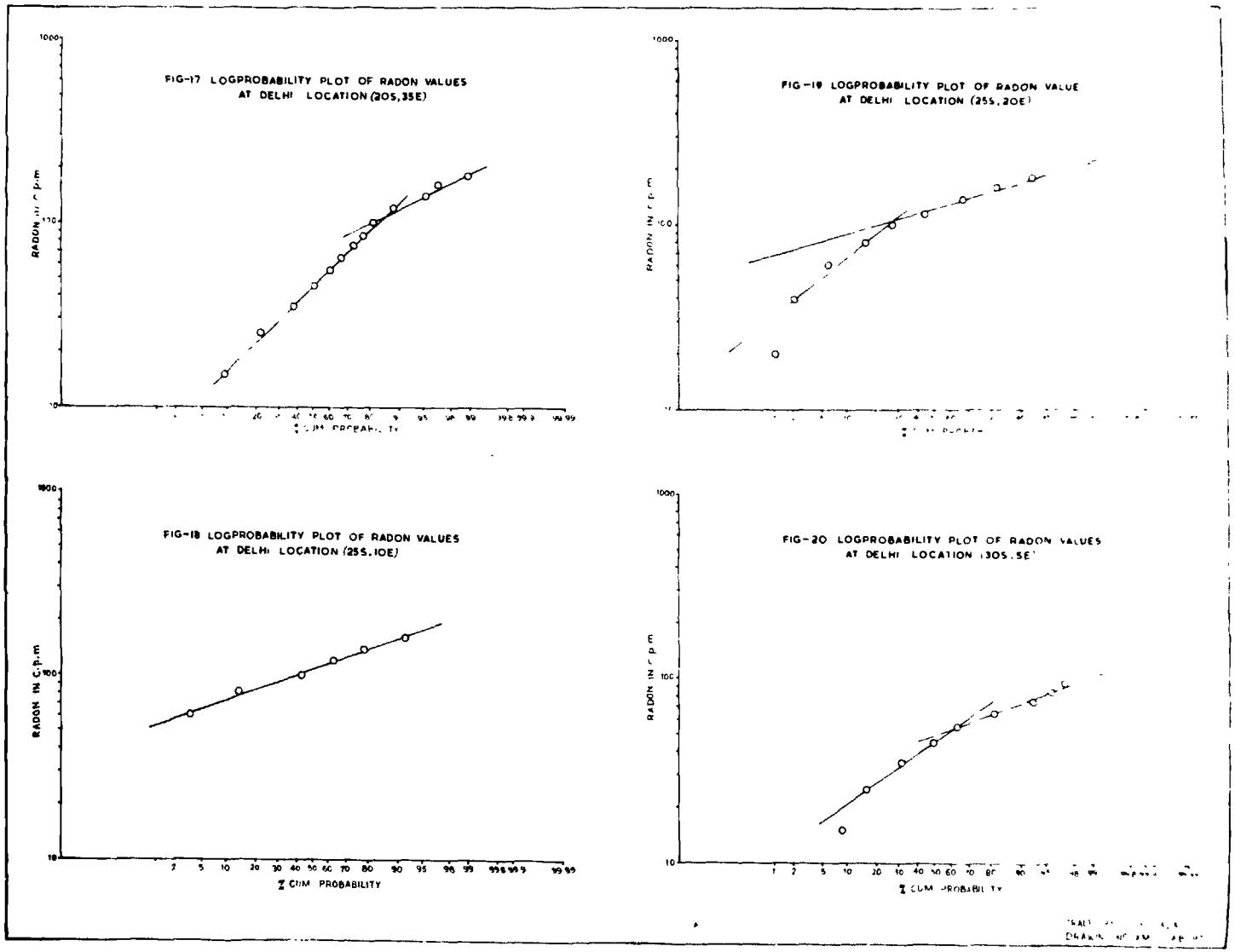


FIG-17 LOGPROBABILITY PLOT OF RADON VALUES AT DELHI LOCATION (20S,35E)
FIG-19 LOGPROBABILITY PLOT OF RADON VALUE AT DELHI LOCATION (25S,20E)
FIG-18 LOGPROBABILITY PLOT OF RADON VALUES AT DELHI LOCATION (25S,10E)
FIG-20 LOGPROBABILITY PLOT OF RADON VALUES AT DELHI LOCATION (30S,5E)
RADON IN C.p.m
% CUM PROBABILITY

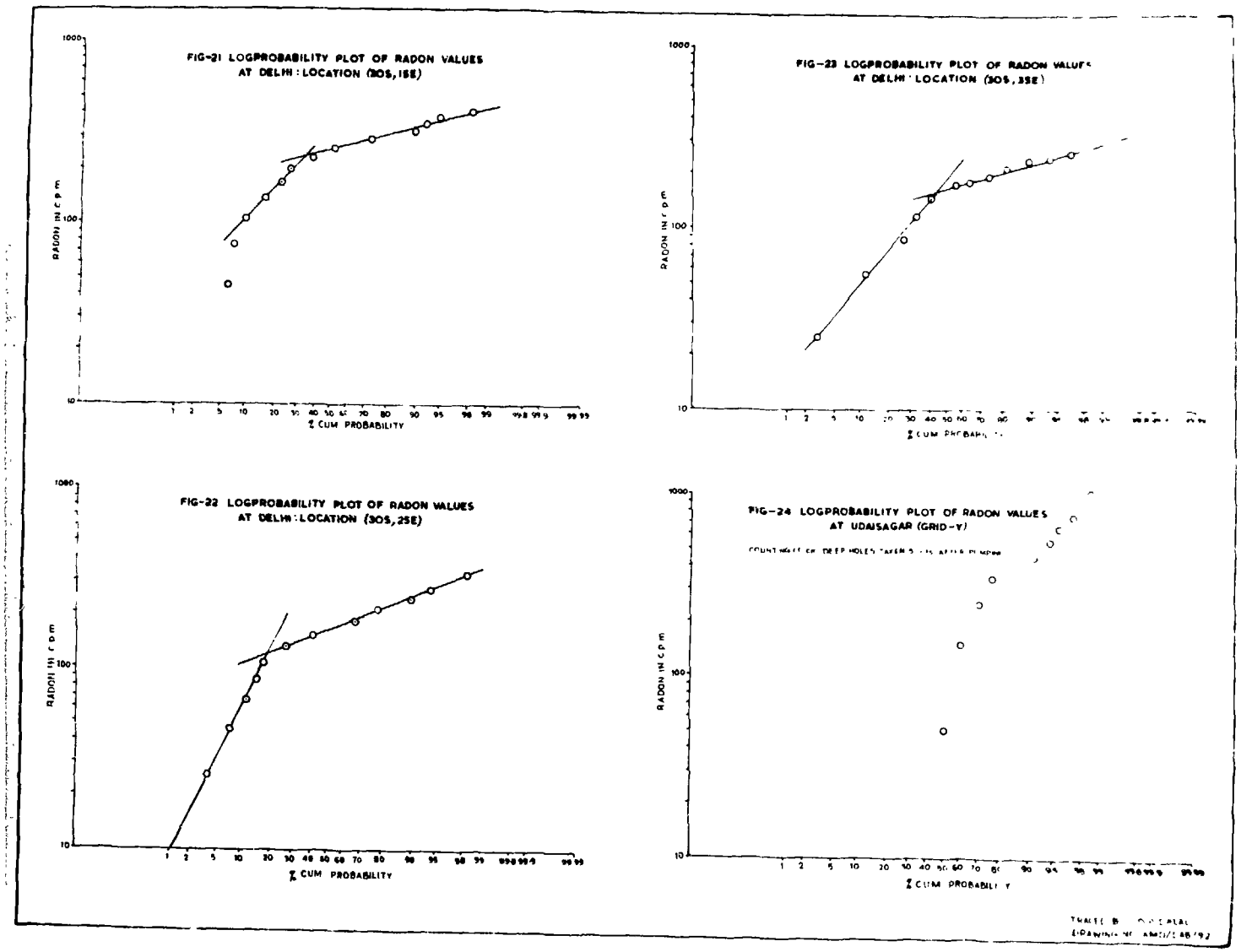
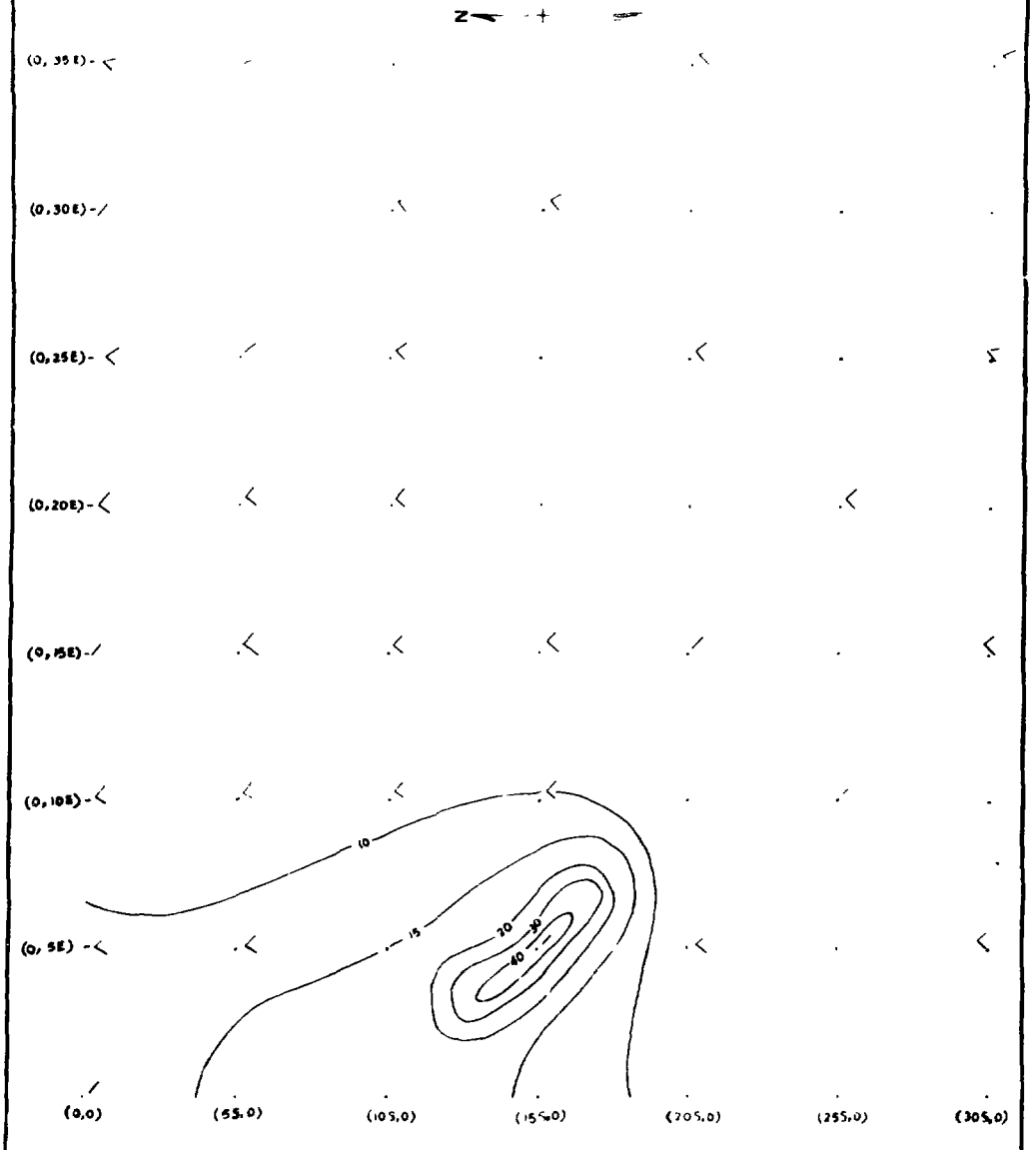


FIG-21 LOGPROBABILITY PLOT OF RADON VALUES AT DELHI : LOCATION (30S, 15E)
RADON IN C P M
% CUM PROBABILITY
FIG-23 LOGPROBABILITY PLOT OF RADON VALUES AT DELHI : LOCATION (30S, 35E)
RADON IN C P M
% CUM PROBABILITY
FIG-22 LOGPROBABILITY PLOT OF RADON VALUES AT DELHI : LOCATION (30S, 25E)
RADON IN C P M
% CUM PROBABILITY
FIG-24 LOGPROBABILITY PLOT OF RADON VALUES AT UDAISAGAR (GRID-Y)
RADON IN C P M
% CUM PROBABILITY

PLATE-I BEHAVIOR PATTERN OF RADON NEAR A RADIOACTIVE SAMPLE DUMP (DELHI)



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HYDERABAD, DATED 14-10-1974
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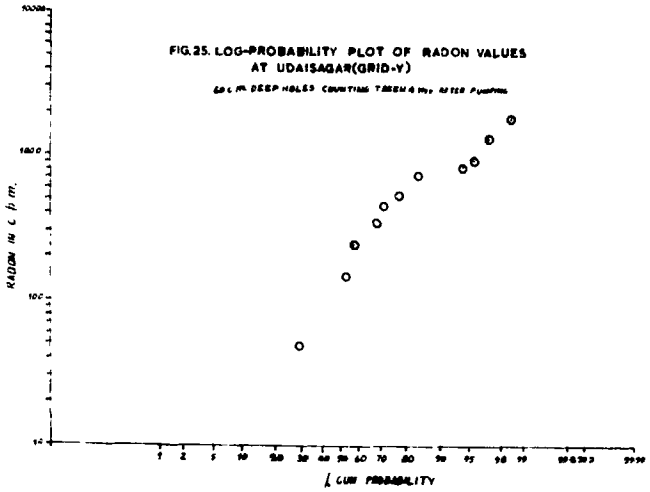

FIG.25. LOG-PROBABILITY PLOT OF RADON VALUES AT UDAISAGAR(GRID-V)

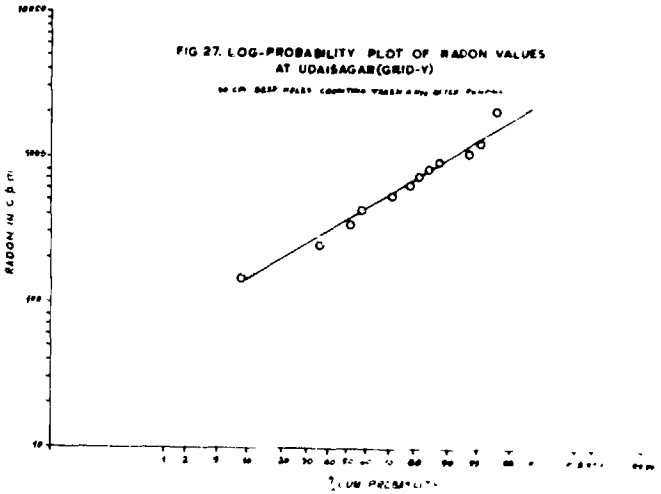

FIG 27. LOG-PROBABILITY PLOT OF RADON VALUES AT UDAISAGAR(GRID-V)

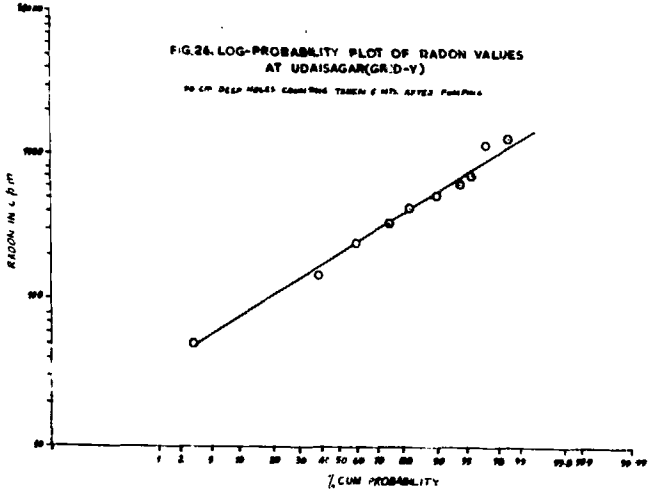

FIG.26. LOG-PROBABILITY PLOT OF RADON VALUES AT UDAISAGAR(GRID-V)

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FIG 28 LOG PROBABILITY PLOT OF RADON VALUES
TURAMDIH LOCATION (TRG III)

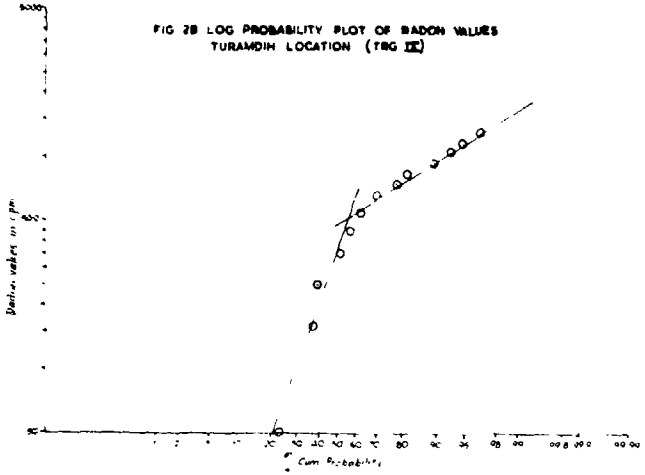


FIG. 29 LOG PROBABILITY PLOT OF RADON VALUES
AT TURAMDIH (TRG I)

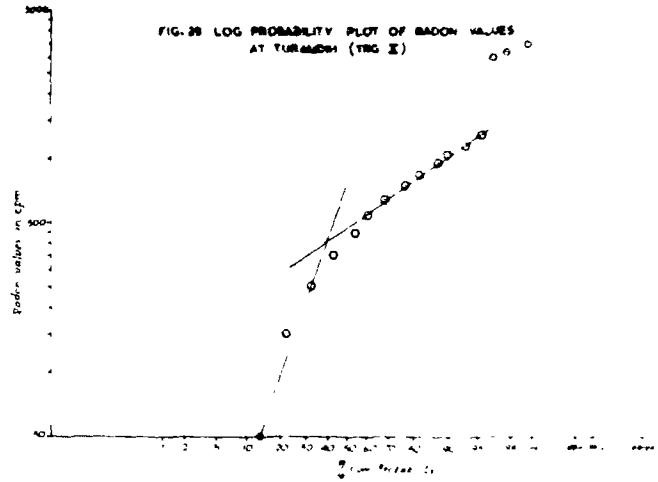


FIG. 30 LOG PROBABILITY PLOT OF RADON VALUES
AT TURAMDIH (TRG IIA)

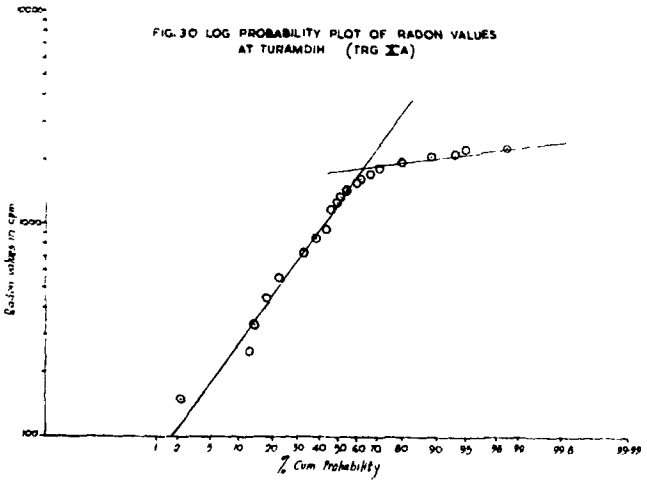
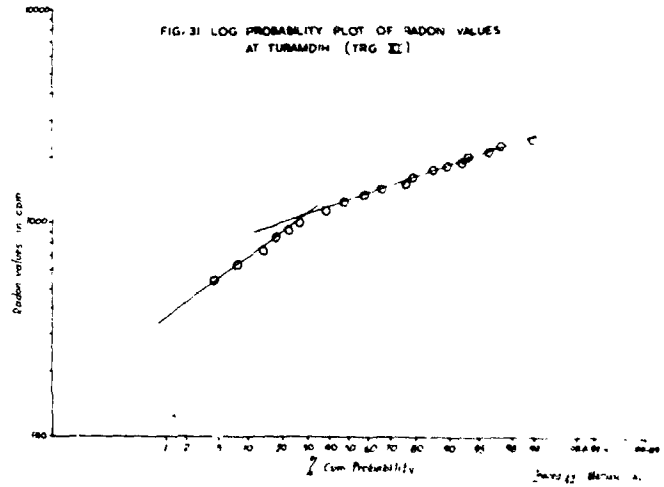


FIG. 31 LOG PROBABILITY PLOT OF RADON VALUES
AT TURAMDIH (TRG II)



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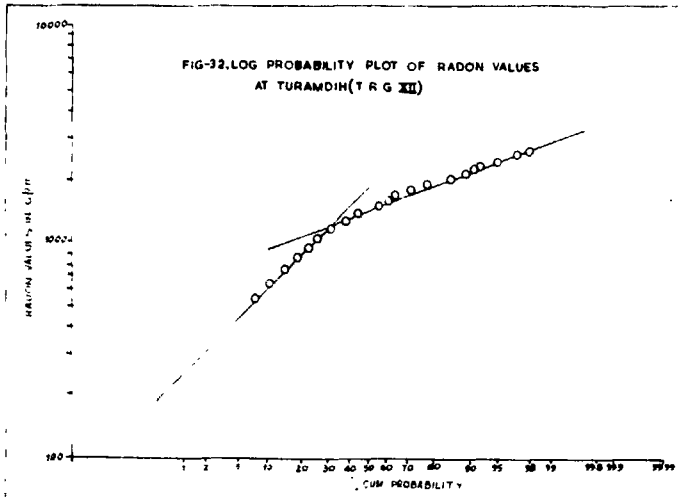

FIG-32. LOG PROBABILITY PLOT OF RADON VALUES AT TURAMDIH (T R G XII)

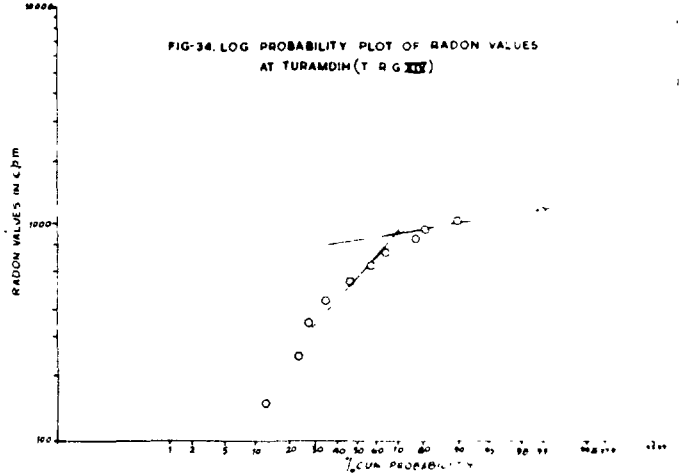

FIG-34. LOG PROBABILITY PLOT OF RADON VALUES AT TURAMDIH (T R G XIV)

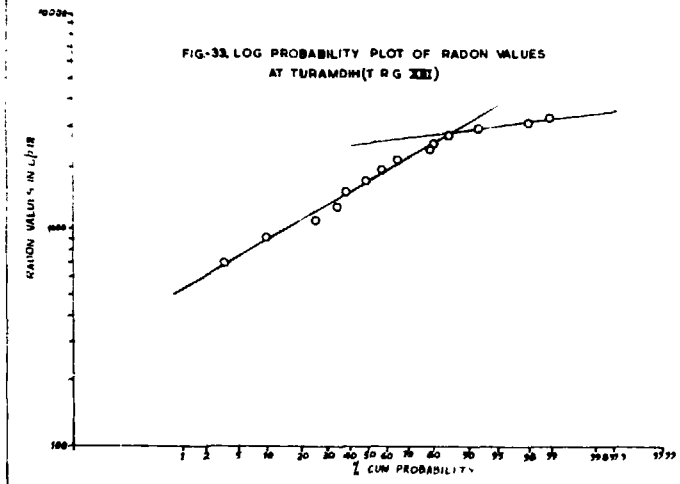

FIG-33. LOG PROBABILITY PLOT OF RADON VALUES AT TURAMDIH (T R G XIII)

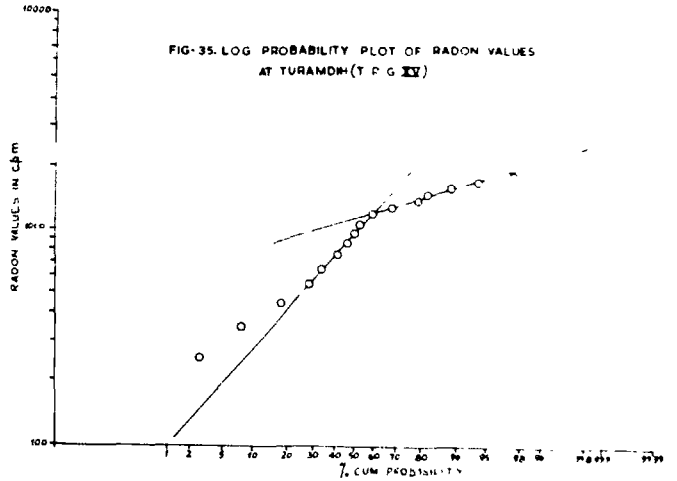

FIG-35. LOG PROBABILITY PLOT OF RADON VALUES AT TURAMDIH (T R G XV)

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Fig 36

LOG PROBABILITY PLOT OF RADON VALUES
AT TURAMDIH (TRG XVI)

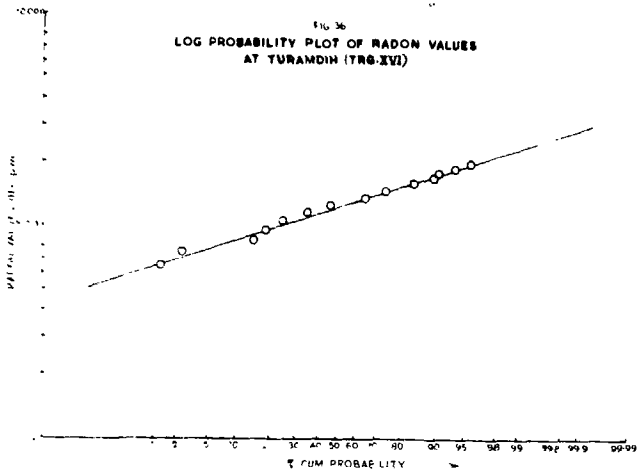


Fig 38

LOG PROBABILITY PLOT OF RADON VALUES
AT TURAMDIH (TRG XVII

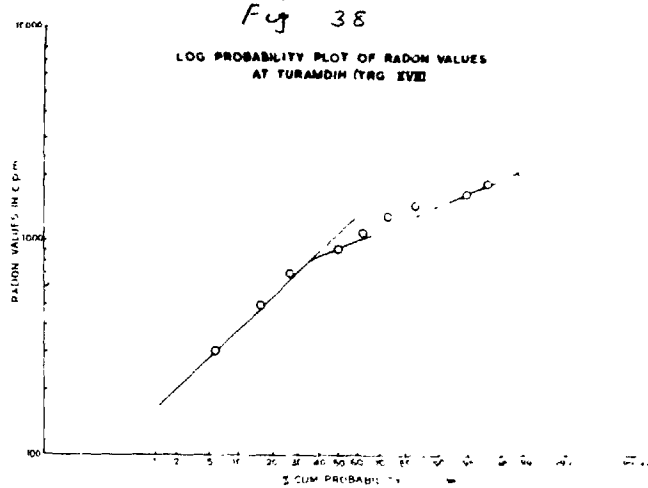


Fig 37

LOG PROBABILITY PLOT OF RADON VALUES
AT TURAMDIH (TRG XVII)

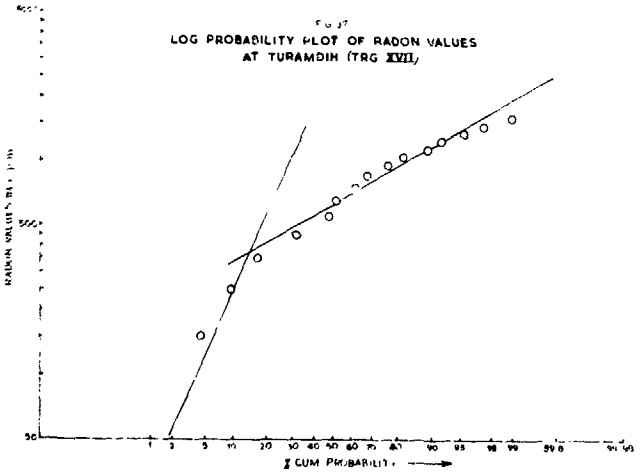


Fig 39

LOG PROBABILITY PLOT OF RADON VALUES
AT TURAMDIH (TRG XIX)

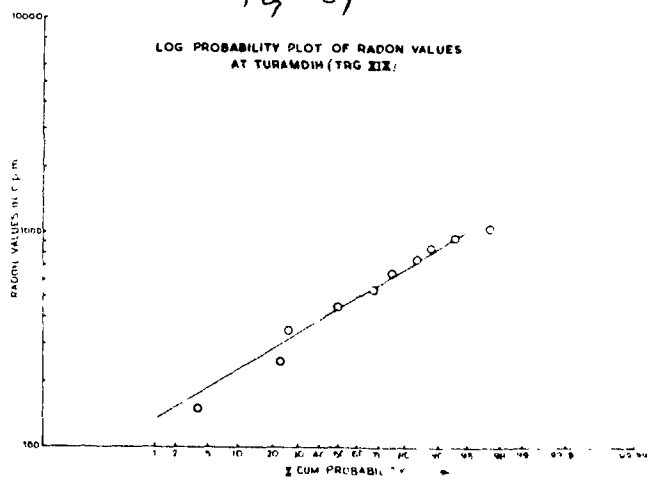


Fig 42

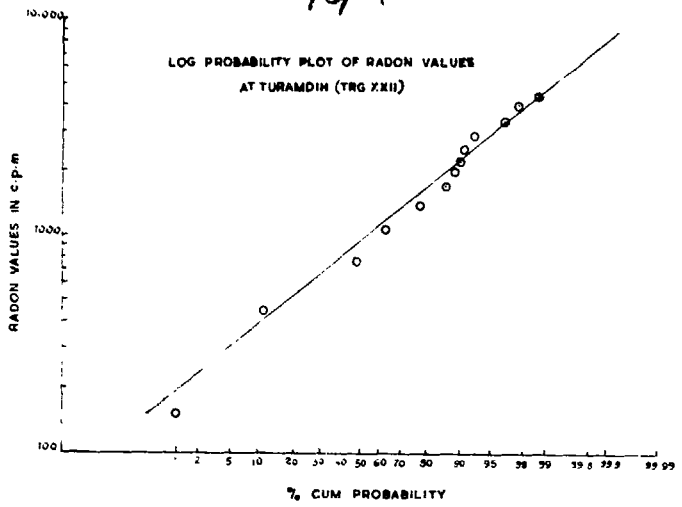


Fig 40

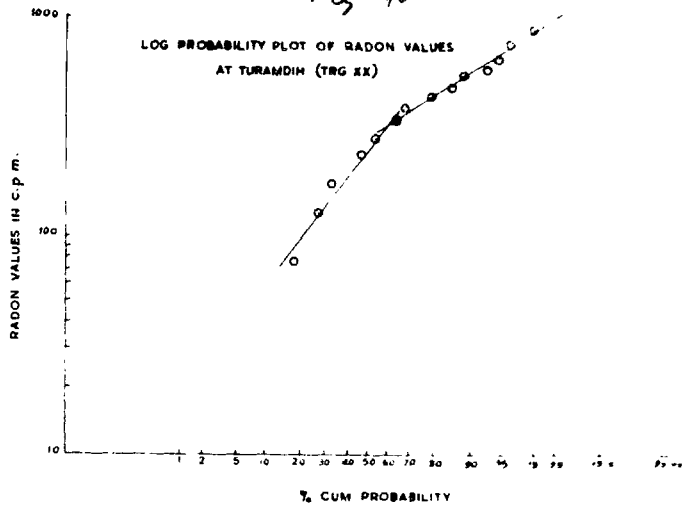
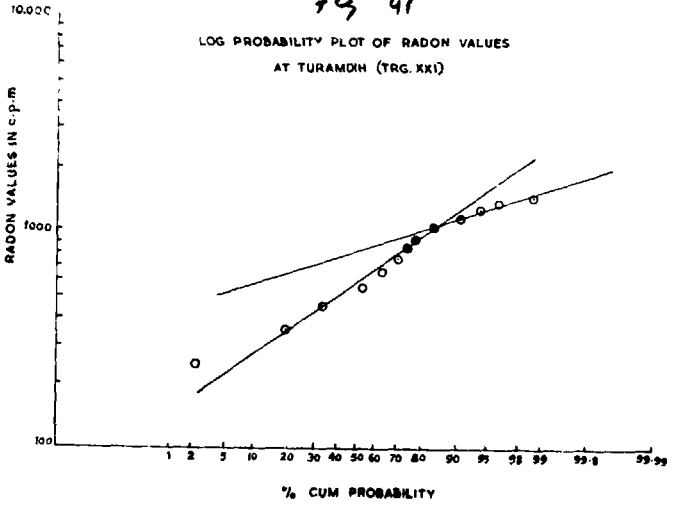
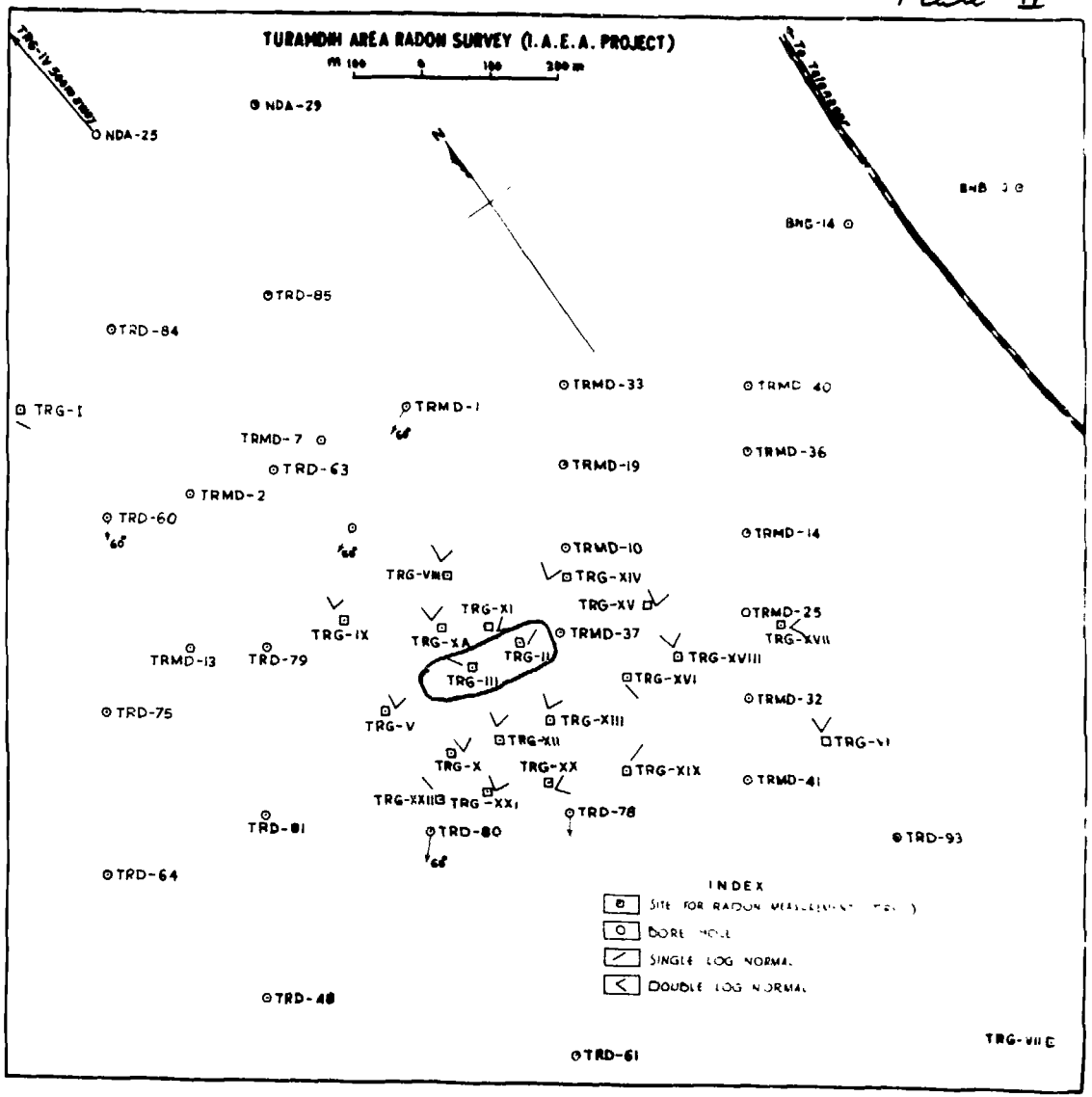


Fig 41



TRACED BY M S VERMA, DMAVT
HYDERABAD, 23RD AUGUST '98
DRG NO AMD/LAB/98

Plate II


TURAMDAH AREA RADON SURVEY (I.A.E.A. PROJECT)
100 0 100 200 m
To Talgarno
NDA-29
NDA-25
BNB-14
TRD-85
TRD-84
TRMD-33
TRMD 40
TRG-I
TRMD-1
TRMD-7
TRD-63
TRMD-19
TRMD-36
TRMD-2
TRD-60
TRMD-14
TRMD-10
TRG-VIII
TRG-XIV
TRG-XV
TRG-XI
TRG-IX
TRG-X
TRG-II
TRMD-37
TRMD-25
TRG-XVII
TRMD-13
TRD-79
TRG-III
TRG-XVIII
TRG-XVI
TRD-75
TRG-V
TRG-XIII
TRMD-32
TRG-XII
TRG-VI
TRG-X
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TRG-XIX
TRMD-41
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TRG-XXI
TRD-78
TRD-81
TRD-80
TRD-93
TRD-64
INDEX
SITE FOR RADON MEASUREMENT
BORE HOLE
SINGLE LOG NORMAL
DOUBLE LOG NORMAL
TRD-48
TRD-61
TRG-VII C