"Study of Dhauladhar granitoids and its correlation with uranium and radon in the ecosystem for active tectonics and earthquake prediction studies"

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Abstract

Inhalation loss due to indoor radon and their short – lived progeny concentrations constitute a major part of the total natural background radiation received by the population. Exactness of this estimate needs to be ascertained from detailed measurement which was carried out in the Dharamshala area of Kangra district of Himachal Pradesh. Exposures to indoor radon and their daughter products are significantly influenced by various factors like topography, house construction, soil type, weather and even the life style of the people. The radon measurement was carried out using passive detector technique with LR115 type II as detector material.

The indoor radon values in air were found to vary from 1194 Bq/m^3 (Lower Sakoh) to 317 Bq/m^3 (Depu Bazar) during winter season. In summer season the indoor radon values in air was found to vary from 719 Bq/m^3 (Barol) to 163 Bq/m^3 (Naddi) area of the Dharmshala with outrage values of both the seasons varying from 815 Bq/m^3 (Barol) to 44.95 Bq/m^3 (Chilgari) of Dharamshala area. In Sakoh area 78.94% houses surveys show indoor radon value of 600-1500 Bq/m^3 which is attributed due to closeness of the area to Drini thrust. The values are higher than the safe limit of 400 Bq/m^3 as proposed by environmental protection agency posing a serious health hazards as radon decay products are radioactive and limited to aerosols present in the indoor air when inhaled pose a threat to lungs that may cause lung cancer.

KEYWORDS: Radon, Dharamshala, environment and health hazards.

I. Introduction

This paper incorporates elaborates details on the petrological and geochemical studies of the granitoids of the Dharamshala area and its correlation whatsoever with the anomalous behavior of radon concentration in the ecosystem of the area. Radon gas emission is correlated with nature of rocks and the geological features like faults, springs, thrusts etc. Based on petrography about 10 samples were geochemically analyzed for major and trace abundances. This data gives the concentration of Uranium and Thorium in the granitoids rocks of the area. As radon is the decay product of uranium its concentration is measured in the. With the help of Solid State Nuclear Track Detectors. A correlation is found between the concentrations of radon in the area with the uranium contents of the rocks

A detailed and elaborate geochemical studies of the granitoids is carried out, the rock types viz. granitoids and metamorphites along with the structural zones (thrusts& faults etc.) which facilitate the easy migration of radon from the deeper parts of the earth crust has shown higher proportion of radon.

The presence of higher radon in the ecosystem and its interrelationship with the geology of the area especially with the geochemistry of the granitoids has thrown light not only on the source of the radon but on the mobility and disintegration of the uranium in the granitoids and the associated rocks. Detailed geochemistry of the various granitic rocks units has helped in establishing for the first time a positive correlation between higher values of radon in the environment and the related elemental concentrations in the granitoids. The measured radon concentration values in air, rocks, soils and water is studied from the point of view for the health hazard assessment and earthquake prediction. Seasonal variation of radon is also studied for correlation of radon gas emission with the local geology.

Geochemical aspects of Dhauladhar granitoids remained unexplored because of its inaccessibility therefore it was necessary to explore this area in detail so as to carry out the study of the geochemical aspects of Dhauladhar granitoids in relation to emanation of radon concentration in the ecosystem as the region is seismically active. Shinde et.al (1988) carried out Geo-botanical survey in parts of Hamirpur district, Himachal Pradesh. Geo-botanical method of survey involve the study of floral cover in order to detect mineralization by means of plant distribution and the presence of indicator plants or mutational or morphological changes by excessive intake of certain pathfinder elements from the bedrock such as uranium. The survey was carried out in two separate basins

(1) Hamirpur basin (NE of Jwalamukhi Thrust) and the Kango basin (SW of Jwalamukhi Thrust he has observed that Sibal Galot area (Kango basin) the uranium values are low (average4.3ppm) .Correspondingly, in the Astotha Mine area (Hamirpur basin) the average value is 96ppm.very high uranium values of 194 and 634ppm were obtained from two firm plants of Adiantium vesuestum. Although no single plant could be established as indicator plant like the Astrugalus Sp., the grass cynadon dactylon shown preferentially high uranium contents in radioactive areas. Choubey and Ramola (1997) measured radon concentration in soil, air and ground water in Doon valley, Garhwal Himalayas usingLR-115 plastic track detectors and radon manometer. Radon concentrations were found to vary from 1KBq/m3 to 57KBq/m3in soil, 5Bq/l to887Bq/l in water and 95Bq/m3to 208Bq/m3in air. The recorded values are quite high due to associated uranium mineralization in the area. The study has revealed high emanation of radon along MBT which results in high rate of radon in soil. The high emanation of radon (op.cit) along MBT has been correlated to the active nature of fault and the lithology of the area.

II. Geology

The Himalaya forms a part of the Alpine -Himalayan orogenic belt extending from Alpine region of Europe to the Indonesian arcs enclosed with the arms of Indus River in the west and Brahmaputra River in the east. This mountain system exhibits spectacular hair-pin or syntaxial bends around Nanga Parbat(8126) in the northwest and Namcha Barwa (7756m) in the southeast(Suess,1904-1924;Wadia,1931)Between these two syntaxial bends ,the arcuate Himalayan range measures about 2400Km in length 240-300Km in width with a radius of curvature of about 1700Km (Gansser,1964). Whose center lies near Lop Nor Lake in the sinking province of China. The convexity of this range is towards the Indian peninsular shield. The Himalayan region has a record of several phases of magmatic activity which suggests that he region was a zone of crustal weakness and episodic rift reactivation for at least 1.5 Ga since middle Proterozioc Times(Bhat,1987).The area under investigation falls in the Lesser Himalaya and constitutes a part of the Dhauladhar Range. Research area is 25Km north of Dharamshala being bound by 32^0-10'to 32^0-20' (latitude) and 76^0-10'to76^0-20'N (longitude) and covered by survey of India Toposheet No. 52D/7 and 52D/8.Area bears a lesser Himalayan topography characterized by gentle to rising rugged mountainous terrains, steep slopes and high peaks shaped by geomorphological processes over geological time. The impact of lithology over surface features is quite evident when one comes up from lower reaches (lithologically sedimentary formations) to upper reaches (hard rock's).The highest mountain chain is Dhauladhar which rises in the east of the Ravi gradually attaining the height of 6000m (Mon peak) elsewhere and 5000m In the area of study (Inder Mar Jot).This range finally merges in the Shimla Himalaya. The mountain ranges falls to 1000 to 1500m in the south and then break into numerous spurs, which are usually concealed under the valley filled glacial deposits comprising erratics and tillites before ultimately disappearing into the alluvium of Kangra valley. The nature has bestowed variety of forests in Dharamshala region. The Pines occur up to 2000mand above that Fir and rhododendron are found. The terraces and piedmont deposits, Siwalik, Dharamshalas and Dharamkot Limestone provide good sites for exuberant growth of Pine and Banoak trees. Ravines and gravels afford sites for the growth of bamboo and other shrubs. In areas covered with phyllites, slates and schists, Kharsuoak and rhododendron grows as the altitude increases. Volcanics are invariably devoid of forests but bear good vegetation. Fir, spruce and rhododendron trees are found over granite and gneisses.

The Himalayan mountains have resulted from the collision of India and Eurasian blocks some 50 my ago, which was accompanied by 2000Km of crustal shortening (Molnar and Tapponnier, 1975). In the post collision phases the active convergence was initiated during the Early Tertiary period along the Indo-Tsangpo Suture, followed by the middle tertiary under thrusting along the Main Central Thrust, the Mani boundary Thrust and late Tertiary THE Main Frontal Thrust. The review papers on the geology of the Himalaya in recent years have subdivided the Himalaya and the adjoining part of Ladakh and Karakorum into the following four principal longitudinal belts (Gergan and Pant, 1983; Valdiya, 1988).

1. Frontal Folded Belt

2. Main Himalayan Belt

3 Indus-Shyok Belt

4. Karakorum Belt

Uranium occurs in two forms U4+ (Uranus) combine with Cl, F, P.So2 below PH3-4 It is undetectable in Natural water and U6+(Uranyal). The cellulose nitrate film (LR 115) was used to record tracks formed by the decaying the daughter product of uranium. Fill detect alpha particles (plate out) in the energy range between 1.7 to 4.8 Mev. The important daughter product of radon 218 Po and 214 Po (6.00 and 7.68 Mev).

Lexon polycarbonate plastic detector record heavy ions such as fission fragments Ar, Ne etc. used in uranium analysis in soil, rock and water. 2.5 N NaOH solution at 60 C for two hours using a constant temperature bath was used to enhance the tracks to the detectible limit to be detected under the olympum microscope 400X magnification. Ions explosions spike model is used in detection of uranium in soil, rock and water. The samples are irradiated at Trombay Bhabha Atomic Research Centre for calibration. For radon in water one count per minute is equal to 0.11 Bq/L. Radon degassing area are maximum uplift and hence have maximum energy and prominent seismic belts. Naddi and Talnu (subsidence and Naddi lineament).

i) Along MBT and MCT where these two thrusts abut against the Subhathu.

ii) Dharamkot thrust marking the boundary between the Chail and Dharamkot limestone. Above it, a trunk of in-situ granite extends from the Triund. At Sakoh, the presence of major structural features is of Drini thrust marking the boundary between Dharamshala and Upper Siwalik.

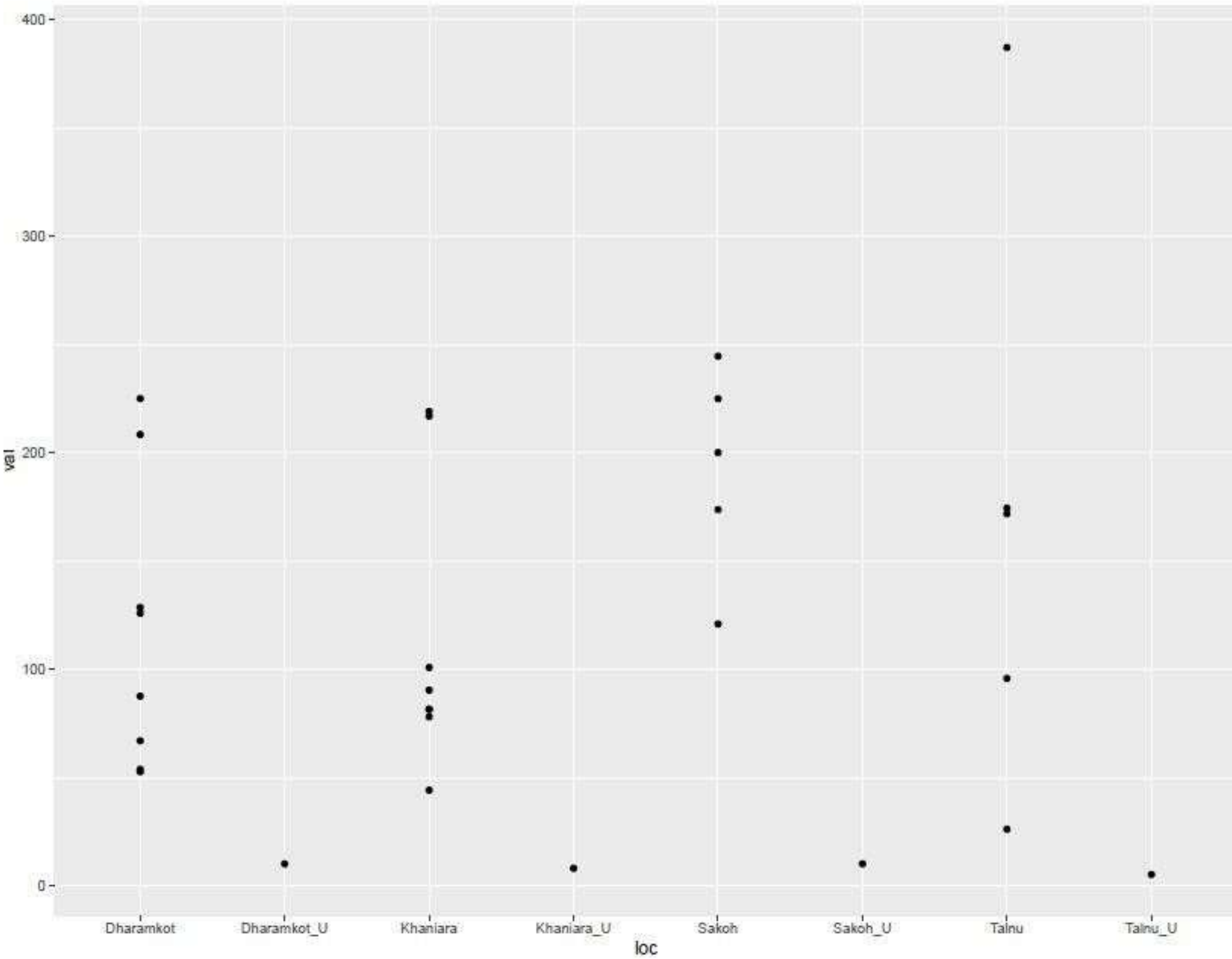
Co2 act as a carrier or diluting agent for Rn. Radon having an atomic number 86. Half life of radon is 3.82 days and for Actinon Rn 219 is 4s and for Thoron is Rn220 is 55s.From the health hazard point of view measurement of radon concentration becomes important as any surface exposed to radon 222 become deposit with short lived daughter product polonium-218, Pb-214,Bi-214,,Polonium and Lead-210

The following radon data for the air (integrated readings) has been absorbed for the Dharamshala region covering both summer and winter seasons and average values calculated.

S.No	**Village Name**	**Winter season**	**Summer season**	**Average**
1	Barol	910	719	815
2	Chilgari	718.6	111.3	414.95
3	Lower Sakoh	1194	348	771

4	Upper Sakoh	992	248	620
5	Naddi	1101	163	632
6	Depu Bazar	317		

Table: 1(Avg. indoor radon values for Dharamshala region)



The control of indoor radon pollution is through the diffusion barriers, which act as heat exchangers for flows sheet of polyamide polyethylene reduced emanations by 97 % and painting the walls reduces emanation by 32.67%, and use of latex as paints reduces emanation further 47-87%. Others precautionary measures are making houses well ventilated and using construction material which are free from radon rich materials.

The high values are mainly due to diffusion of Radon through fault, fracture, joints and shears. Main Himalayan Belt (MHB) thrust centre with Frontal Folded Belt (FFB).

In Sakoh area 78.94 houses surveys shows indoor radon value of 600-1500 Bq/m^3 which is attributed due to the closeness of Sakoh area to Drini thrust and Manjhi Khad lineament. These values are higher than the safe limit of 400 Bq/m^3 as proposed by environmental protection agency posing a serious health hazards as radon decay products polonium-218 and lead 24, bismuth 214, polonium and lead 210 are radioactive and linked to the aerosols present in the indoor air when inhaled posed a threat to the lungs, thus causing lungs cancer.

80.26 % houses have Radon values in the range of 200-600 Bq/m^3 in Naddi village. Values are significant because of the presence of thrust zone and subsidence area. In Sakoh village 40% houses have drinking water radon values higher than the safe limits. In Naddi village 60% houses have values of radon in drinking water higher than the safe limit of 400 Bq/l. This is because of high permeability of thrust zone.

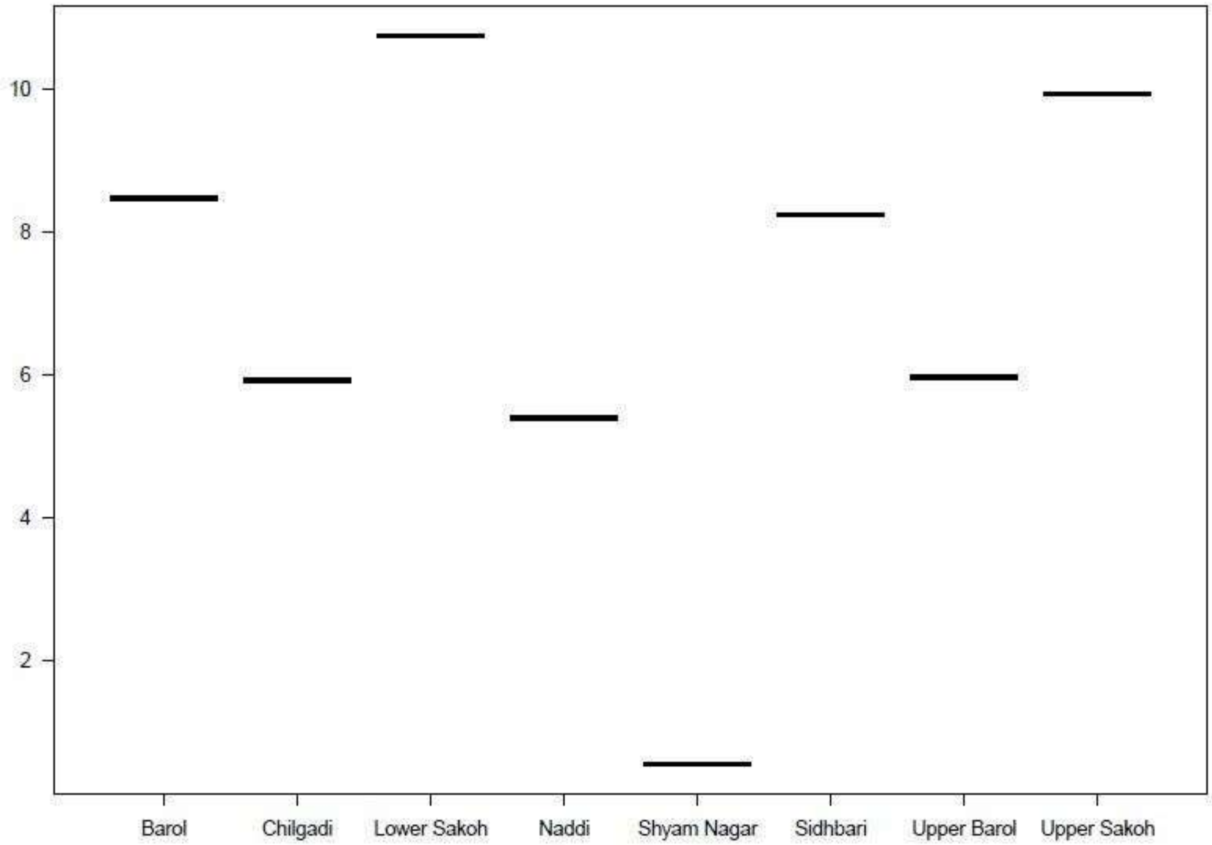
III. Soil exhalation of radon

Radon exhalation rate in the soil varies from 7.25 mBq/kg in Depu bazar to 221.4 Mb/kg in lower Sakoh. This may be due to the difference in the uranium and radium content of different locations or due to the difference in nature and origin of the soil. The high exhalation rate in soil samples of lower Sakoh is 221.4 mBq/kg; upper Sakoh 49 mBq/kg, Naddi 36.2 mBq/kg is due to the closeness of lower Sakoh and upper Sakoh to the Drini thrust and Manjhi khad lineament and closeness of Naddi area to the longitudinal Chail thrust and the transverse Naddi lineament. Fault and fractures zones act as channel ways for the fluids and promote migration of different chemical element including radioactive elements eg. Uranium in reducing condition it is immobile in oxidizing condition and, thorium immobile stable mineral is thorite and monazite, radium is mobile and radon which diffuses and get dissolved in the water.

Soil exhalation of radon in Dharamshala region

S.No	Name of village	Soil radon exhalation rate (mb/kg)
1	Upper Badol	2.4
2	Naddi	36.2
3	Sidhbari	73.2
4	Chilgadi	1.07
5	Shyam Nagar	14.5
6	Lower Sakoh	221.4
7	Badol	32
8	Upper Sakoh	49
9	Dari	112
10	Depu Bazar	7.4

Table: 2 (Soil exhalation of radon in Dharamshala region)



The MBF also known as Shali thrust. These are the major sites for soil exhalation studies and soil gas radon measurement along with the major zones of deformations across the Siwalik in the study area. MBF Himalayan frontal fault and foothill fault, MBF2, these tectonic plains divides the bed into three zones, the zone 1 consist of Subathus and murres Dharamshala), the zone 2 includes Siwalik group and is characterized by the presence of a number of thrusts such as Jawalamukhi thrust, Dehra-Gopipur thrust and Drini thrust.

The lesser Himalayas, Dharamshala bed act as pre Siwalik and post Subathu sediments. In lesser Himalayas especially in Dhaladhar granites contact aureoles caused by granitic contact with metamorphism on the country rock belonging to Chandpur-chail series. These contact aureoles has a significant role in soil gas emission. The basal litho unit of Chail group is marked by the occurrence of prominent zone of augen gneiss; shali phyllites, mica schist and schistose quartzite overlie a basal unit. Structural dislocation and inversion of strata of chails Dharamshala traps are well exposed in a linear belt from North West of Dharamshala i.e. Kareri village to Palampur. In the Dharamshala area, they are laying above the Dharamkot limestone with a thrust contact. In the area under study rocks of chail group are overlying the Dharamshala traps along a chail thrust. Southward these volcanics have thrust contact with the Dharamkot limestone up to Manjhi khad in Dharamshala area. These contact is further controlled by a strike slip fault which dips to north east with an angle of 45 degree to 50 degree. In the Manjhi had section, these volcanics are in a thrust contact with the subathus formation and red shales of the Dharamshala group. Gallu pass area, intense shearing of volcanics near the thrust contact because of which basic and metabasic volcanics are highly altered in nature. Volacanics increase in thickness in the Triund section exposed east of Dharamshala towards Jia. Presence of five flows within volcanics are exposed near Khari Behi all these contact and fault formed the important areas for radon measurement in soil gas measurement for regular monitoring in requirement of any earthquake prediction relate studies. The above table of soil gas radon measurement has shown significant correlations of radon gas emission with the faults and thrusts. These comprise the radon studies in the main Himalayan belt of Dharamshala region starting from Dhauladhar granitoids to chail metamorphics, volcanics and Dharamkot limestones and Dharamshalas.

III. (I). Fronted folded belt

Central folded belt comprises of Siwalik succession of upper Siwalik, lower Siwalik and middle Siwalik starting from Dharamshala to north east of Yol. The southern slope of Dhauladhar range is covered by alluvium. In villages Gharoh khas, Sakoh and kaned and south of Thana village the upper Siwalik conglomerate dipping to the north covers these upper Siwalik sediments are characterized by the accumulation of conglomerate deposits. These are well exposed along the khad section that is Sakoh village along Churan and Manjhi and Gaj khad, Baner khad and Neugal khad near Manjha village. The megascopic structures part of local structures that are major faults and thrusts sediments and basement rocks in the main Himalayan belt are the most important tectonic plains for the degassing of radon in the soil and air.

Frontal folded belt tertiary and quaternary sediments, Subathu, Dharamshala and Siwaliks resting over the Paleozoic basement are separated into three zones each zone is separated by tectonic plain. Southern most thrust which separate the Siwalik group from Dharamshala group is known as Drini thrust. In the study area, north-west of Gaj khad section to east of Neugal section. In the north, Dharamshala are in contact with the Dharamkot limestone along the MBT (Shali Thrust) from Kareri to Manjhi khad, however in the Manjhi khad section, Dharamshala abuts against the subathus with a thrust contact. The subathus in the Manjhi khad section occurs as a tectonic wedge in the main boundary trust. A enlarge cross section of this particular area shows the position of various rock units present in the area. The wedge may be indicative of considerable movement as up thrown block along the thrust plain. Further, east of Manjhi khad, there is a complete absence of Dharamkot limestone and the Dharamshala traps are thrust over the Dharamshalas. Main Himalayan belt consist of Dharamkot limestone, Dharamshala trap, chails and Dhauladhar granitoids.

The central crystalline of higher Himalayas marked by the boundary of main central thrust in the north followed by lesser Himalayas and bounded by main boundary thrust in the extreme south. Lesser Himalayan range merges with the Shimla Himalayas. In Jammu region, Jammu hills composed of nappies and thrust sheet made up of thick metamorphics (low to high grade and sedimentary rocks) overlain this klippe unit consisting of granite gneisses and meta-sedimentary rocks.

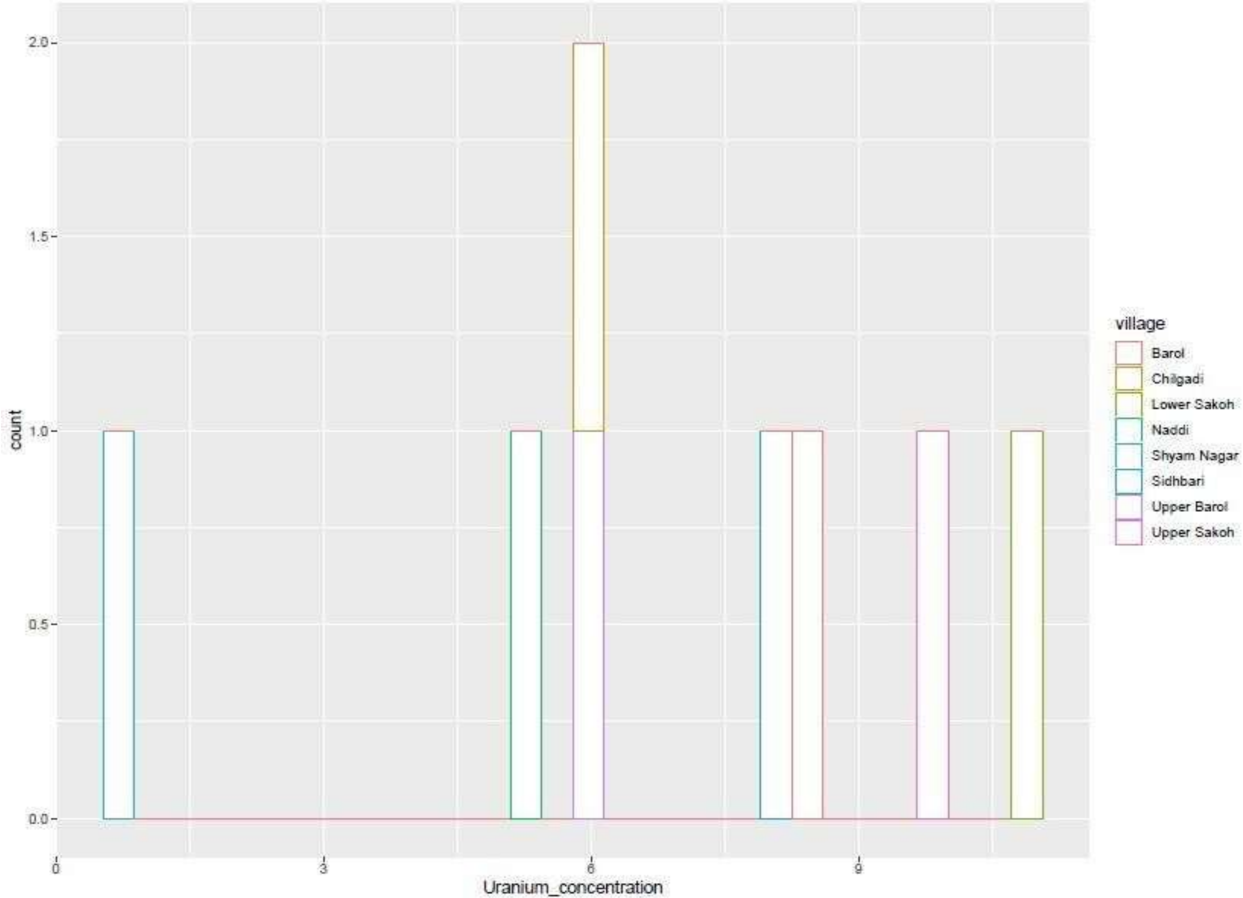
IV. Uranium analyses of soil, water and rocks samples from Dharamshala area

Uranium a primordial radio nuclide occurring in a dispersed state in the earth crust .Due to its property to get dissolved in aqueous solution in hexavalent (U 6+) and to precipitate as a discrete mineral in tetravalent (U4+) form it forms deposits in the earth's crust where the geological conditions becomes favorable. Uranium present in the earth is transferred to water, plants, food supplements and then to human beings. According to an estimate, food contributes about 15%of ingested uranium while drinking water contributes about 85%.An exposure of about 0.1% mg/Kg of body weight of soluble natural uranium results in transient damage to the kidneys (lussenhop et al., 1958).

The high exhilaration rate in the soil sample of lower Sakoh and uranium in soil (221.4 mbq/kg, 10.74 ppm) upper Sakoh and uranium in soil (49 mBq/kg, 9.2 ppm), Naddi and uranium in soil (36.2 mBq/kg, 5.40 ppm) is due to the closeness at lower Sakoh and upper Sakoh to the Drini Thrust and Manjhi khad lineaments and closeness of Naddi area to the longitudinal Chail thrust and the transverse Naddi lineament.

S.no	Name of village	Uranium conc (ppm)
1	Upper badol	5.97
2	Naddi	5.40
3	Sidhbari	8.24
4	Chilgadi	5.92
5	Shyam nagar	0.56
6	Lower sakoh	10.74
7	Barol	8.47
8	Upper sakoh	9.92

Table: 3 (Uranium conc. In Dharamshala region)



s.no	Rock samples	Uranium concentration (ppm)
	Porphyritic granite	0.676
	Fine grained granite	10.33
	Coarse grained granite	1.98
	Altered granite	7.22
	Coarse grained granite (higher location)	1.20
	Granite (max. biotite Fe-Mg minerals)	1.82
	Contact zone granite	0.54
	Typical coarse grain (var.)	3.25
	Massive granite	3.27
	Foliated granite	2.86

Table: 4 (Uranium conc. In rock samples of Dhauladhar granitoids)

Uranium in water region of Dharamshala region

S.no	Name of village	Uranium conc (ppb)
	Upper badol	1.23
	Naddi	0.78
	Sidhbari	16.26
	Chilgari	1.07
	Shyam nagar	1.78
	Sakol	2.05
	Badol	8.83
	Upper sakoh	12.0

Table: 5(Uranium in water region of Dharamshala region)

Hydro-geochemical prospecting for uranium deposits is based on the availability of uranium and its disintegration products, radium and radon to dissolve in water and migrate together with them. The elements of interest in geochemical exploration for uranium are uranium and its decay products. Fine grain granite (10.3 ppm) and altered granite 7.2 ppm has been found to contain high uranium content whereas extremely low uranium content of 0.54 ppm has been observed in contact zone granite. Such a large difference of uranium content in rocks clearly delineates. The difference phases of uranium mineralization of rocks

The uranium content in the water samples is found to vary from 0.78 ppm in NADDI village to 16.26 ppm in Sidhbari village, upper Sakoh 12.0 ppm, Barol 8.8 ppm are fond comparatively higher than in the samples from other villages. From the data of uranium in water, and radon in water correlation coefficient of 0.18 is observed which is of poor correlation. This poor correlation seen to be due to the fact that the radium separated from uranium and precipitating for a long time on the wall of the fractured rock may ave become source of radon in water.

The major minerals of uranium are monazite, laporite, uraninite (uo2), thorite, pitchblende (u3o8), carrotite, branirite etc. uranium is falls in actinide group and has lithophile character. Uranium dissolve in aqueous solutions get into the human body by food intake contributing to 15 % and by drinking water by 85 % of the total uranium ingested by human. 0.1 mg/kg of body weight of soluble uranium results in chemical damage to the kidneys. 1.9 micro g of uranium is considered as a safe limit as given by ICRP-30, 1976. 0.61 correlation coefficient of radon in soil and uranium in soil is observed which a good correlation is. Correlation coefficient of 0.46 is observed in radon in water and uranium in soil which is a significant correlation. Correlation coefficient of 0.44 is observed in uranium in water and uranium in soil which is also significant. A correlation coefficient of 0.57 is observed in radon in air and uranium in soil which is also a good correlation.

V. Soil gas radon measurements and Geochemistry

Himalayas have been divided into Paleozoic, lower Tertiary to Tethyan Himalayas grading into Precambrian metamorphic rocks of great Himalayas. These are separated by Main Central Thrust (MCT) which cut upon Quaternary deposits. This boundary marks the beginning of lesser Himalayan tectogenic comprising of pre Tertiary clastic sedimentary rocks. Another major fault boundary is the Main Boundary Thrust (MBT) which displaces Quaternary deposits marking the boundary between lesser Himalayas and the Sub Himalayas forming and exposing Tertiary, Quaternary deposits comprising the sediments of the Siwalik group.

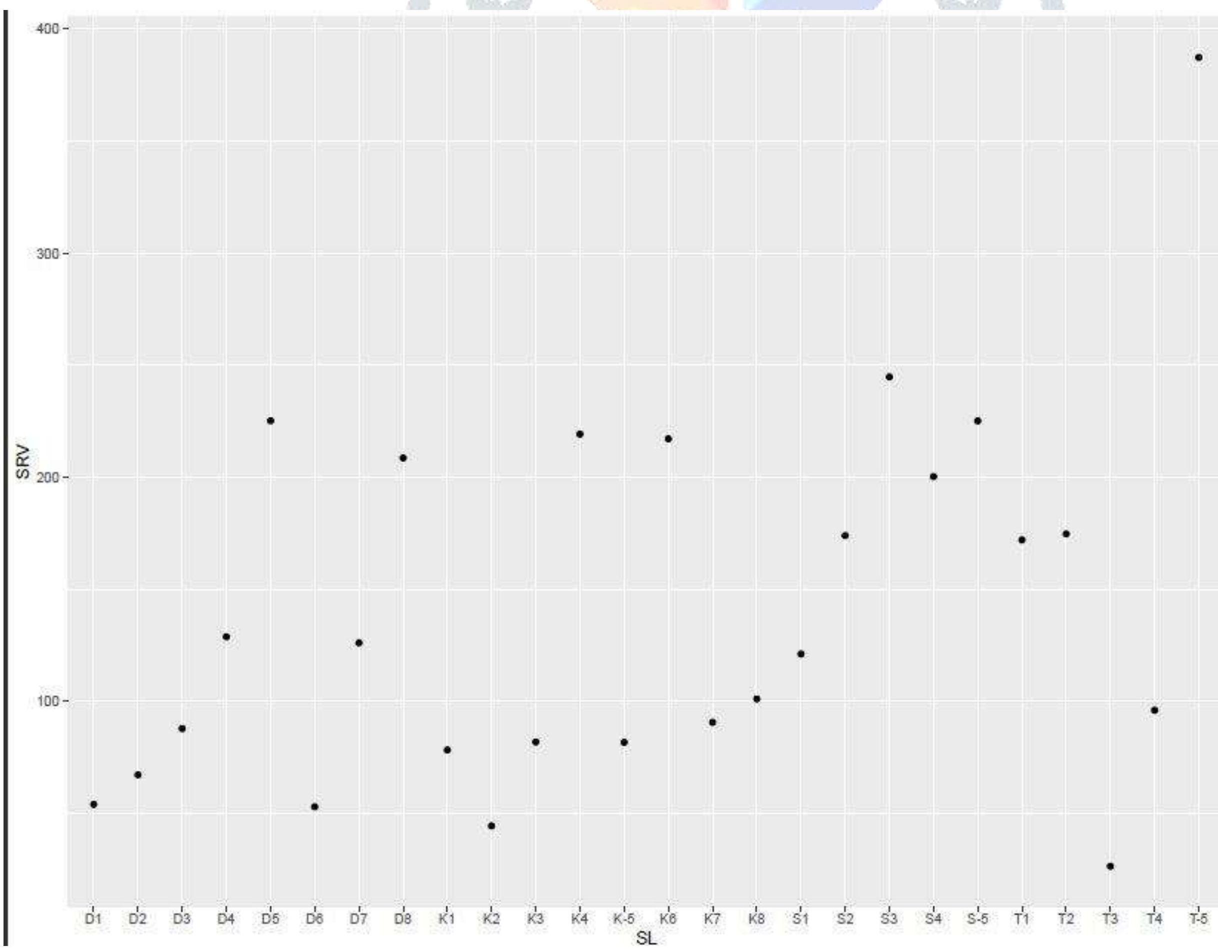
Next major structural features HFT transport sediments of Siwalik group southward to over the indo gangatic plains marking the boundary between Siwalik and indo gangatic plain fill flexural relative to subduction of the Indian continents between Eurasian plate.

Plate boundary thrust dips 6 degrees towards north, 17 km deep in northern edge in the region beneath the great Himalayas. The range of radon soil gas values range from 44.35 kBq/m^3 to 219.23 kBq/m^3. 7.4 mBq/kg soil exhalation rate of radon in Depu bazar area is 7.4 mBq/kg, Dari 112 mBq/kg, in Naddi 36 mBq/kg, in lower Sakoh, in upper Sakoh 49 and Sidhbari 73. Soil exhalation rate is high in these areas as faults and fractures zone act as channel ways for the fluids and promote migration of different chemical elements including radioactive elements.

S. No.	Name of Village	Sample location	Soil radon value Bqm^{-3}
1	Dharamkot	D_1	53000.96
		D_2	67000.15
		D_3	87000.77
		D_4	128000.75
		D_5	225000.21
		D_6	52000.8
		D_7	126000.05
		D_8	208000.60
2	Talnu	T_1	172000.01
		T_2	174000.64
		T_3	26000.30
		T_4	95000.95
		T_5	387000.36

3	Sakoh	S_1	121000.08
		S_2	173000.95
		S_3	244000.78
		S_4	200000.26
		S_5	225000.14
4	Khaniyara	K_1	78000.24
		K_2	44000.35
		K_3	81000.79
		K_4	219000.23
		K_5	81000.62
		K_6	217000.12
		K_7	90000.55
		K_8	101000.01

Table: 6 (Soil gas measurement study along Drini Thrust MBT & MCT at Ghaniyara, Talnu, Naddi and Sakoh)



Geochemistry of Dhauladhar granitoids in relation to the uranium abundances and related radon gas emission in the eco system. Dhauladhar granitoids falls in the syn collision field as plotted in the R1, R2 diagram. Of Dhauladhar granitoids have chemical characteristics from I and S type (NA2O VS K2O diagram). The total alkali sites shows progressive enrichment in alkalis and impoverishment of Mg and Total iron suggesting a course of crystallization through fratination depicted on the bases of AFM and CNK diagrams. Dhauladhar granitoids falls in the per aluminous field on the basin of A/CNK diagram.

VI. Trace elements geochemistry

Kd factor which is the important in determining whether the trace element is either prefer or rejected during the course of crystallization is given as Kd in mineral divided by Kd in melt=1, neither preferred nor rejected less than 1 element tent to remain in fluid greater than 1 element tend to incorporated in the crystalline phase. The variations of falling trace element in the Dhauladhar granitoids is as follows.

Uranium varies from 2.5 to 17.6 ppm, strontium varies from 15 to 131 ppm. Strontium low value is due to feldspar melt fractionation, barium varies from 36 to 492 ppm, rubidium varies from 171 to 466 ppm, and zircon varies from 33 to 250-ppm acidic environment increase in later differentiates. Thorium varies from 7-61.1 ppm. The radium strontium diagram shows higher rubidium and higher strontium due to magmatic fractionation. Barium-rubidium greater than barium shows enrichment in late hydrothermal stage and barium-strontium diagram shows fractionation of alkali feldspar. The geochemical diagram of 1000* gallium /Al vs Zr diagram shows that Dhauladhar granitoids plot in the I and S type and hence low abundance of Zr as compare to A type granites.

1000*Ga/Al vs Zr + Nb+ Y plot of Dhauladhar granites classified them as M-I and S type (OGT field). 1000*Ga/Al vs Nb plot of Dhauladhar granites classified them as I and S type. Nb vs Y diagram for tectonics settings plays the majority of the samples Dhauladhar granitoids into SYN-Colg-collision granites

In addition, plays two samples in the WPG field (within plate granites). Geochemical diagram for Y+Nb+Rb plot Dhauladhar granitoids in M-I-S types. From both these diagrams, the Dhauladhar granitoids plot in the field of vag and volcanic arc type granites, COLG, SYN-Collision. Low abundance of Y and Nb.

Collision granites are divided into syn and post collision syn in setting are limited to crustal thickening due to the under thrusting of one crustal slice beneath another. Post collision granites are limited to rapid post collision uplift. Hence, COLG and VAG can merge Rb and can be enriched by partial melting and fractional crystallization. The low concentration of Nb +Y are due to depleted source and crystallization of amphibole which provide increase in concentration of Y +Nb. U/Th diagram shows value 0.08-7.18 (2.17) less than 3.8. Radioactive elements modified in the surfacial environment during weathering when uranium is removed with respect to Th.

Heat production studies of Dhauladhar granitoids

The following formula was used to calculate the heat production of Dhauladhar granitoids

1.31-9.38 HGU (3.71)

The heat production value of continental crust is 3.8. In the case of Dhauladhar granitoids, low values are due to potash depletion accompanying hydrothermal alterations. HHP act as heat engine for circulation of ore bearing hydrothermal fluids derived from recycled dehydrated continental crust, these are A type granites and derived from melting of sub ducted oceanic crust are M type granites. I types granites are formed by melting of igneous crust and S type are derived from sedimentary protoliths.

VII. CONCLUSION:

- A correlation coefficient of 0.57 has been observed between uranium in soil samples and radon in air which is a good correlation
- The site showing maximum Radon concentration in soil is Khaniyara which is close to MBT & MCT
- Indoor Radon survey in the valleys of Dharamshala areas shows average Radon values in air for both the seasons vary from 414.95 Bq/m^3 in Chilgaari 815 Bq/m^3 in Barol village

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