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Uranium and Radon Anomalies in the River System of N - W Himalayas

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Our laboratory has been engaged in uranium and radon studies in the soil and groundwater using Track - Etch Method. The water samples from springs, streams and river systems in N - W Himalayas, namely Kulu, Kangra, Garhwal and Dehradun areas, were collected and analysed in the laboratory. The uranium content varies from 0.89 to 63.4 ppb. The radon content ranges from 34 to 364 Bq/L. Generally it is observed that radon concentration follows the uranium trend in water but in some areas U - Ra disequilibrium exists.

INTRODUCTION

The natural activity of water is due to the activity transfer from bed rock and soils. The radon transfers from the surface of solids to the natural water where its mobility is greatly enhanced. The radon detection in water and soil indicates the high potential for the detection of structural features as well as uranium occurrences. Surveys utilizing the radon content of natural waters (ground, spring, stream, river and lakes) as an indicator of thorium and uranium deposits havs been carried out since early in the present century (Behounek, 1927). The methods and surveys of radon estimation in water and soil are reported (Bhimashankaram, 1974; Dyck, 1972; Sarin *et al.*, 1972a; Ramola *et al.*, 19 89; Singh *et al.*, 1986). The radon contents in water samples collected from the different springs, streams and river systems in N - W Himalayas were analysed by the Track - Etch method in the laboratory. The water samples were taken from the Siwalik Himalayas of Punjab and Himachal Pradesh and Lesser Himalayas of Garhwal and Dehradun.

GEOLOGY OF THE AREA

The upper part of the lower Siwalik and Middle Siwalik formations in Ramshahr - Kalka Morni region near Chandigarh comprises of hard grey to greenish sand stones and interbeded intraformational clay conglomerates (Udas and Mahadevan, 1974). The formation in Chhinjra and Kasol (Kulu) areas of Himachal Pradesh is quartzite overlain by chlorite schist and gneisses. Veins of pitchblende occur in the crests of anticlinal folds in quartzite (Dar, 1964; Das *et al.*, 1979). The geological formation exposed to water Ganges (Garhwal Himalayas) comprise; tillities, lime stone, shale intercalated with silt stone and sandstone in areas around Rishikesh (Sarin *et al.*, 1992b). The phosphorite horizon of Mussoorie syncline in the Lesser Himalayan region of Uttar Pradesh occurs at transition zone between underlying krol limestone and overlying Tal shales and sandstone and has intercalations of chert and black shales.

EXPERIMENTAL

The determination of radon in water involves degassing an aliquot of sample with air to the evacuated vessel which contains the alpha detector. Water samples collected from different locations were taken into reagent battle connected with a conical flask through a hand - operated rubber pump and U - tube containing $CaCl_2$ to adsorb the moisture in closed circuit (Singh *et al.*, 1984). LR - 115 (Type 2) cellulose nitrate films were suspended in the conical flask to record the alpha emitted by the decay of radon. The technique used for uranium estimation in water using plastic track detector is the same as reported by Fleischer *et al.* (1975). The uranium concentration in water was determined using the formula :

$$C_w = TM/V_g N_a E \sigma \Phi$$

Where T is the total number of tracks counted over the detector disc, N is atomic weight of uranium isotope (238), V is volume of water (0.04 cm^3). G is geometry factor taken as unity, N_a is Avogadro's number, E is etching efficiency (assumed to

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Table 1. *Radon and uranium content in water samples*

Sample area	Rn content, Bq/L Min	Max	Regional threshold, Bq/L	U content, ppb Min	Max	Regional threshold, ppb
Kulu	64.40	364.50	231.62	0.89	37.40	5.62
	(176.12)			(5.34)		
Kangra	34.00	202.80	209.50	0.20	20.31	2.70
	(132.10)			(8.14)		
Siwalik	105.80	223.10	197.21	0.42	21.08	5.86
	(159.80)			(1.72)		
Garhwal	47.70	345.20	212.75	0.89	33.40	8.01
	(150.20)			(5.34)		
Dehradun	130.24	323.01	190.55	2.41	63.40	8.72
	(161.30)			(16.14)		

Note : Mean value given in parentheses

Table 2. *Rn and U anomalies identified in water samples*

Sample location	Area	Rn content, Bq/L	U content, ppb	Remarks
Shat-Chhinjra	Kulu	323.01	8.01	Related to Shat - Chhinjra and Kasol mineralization
Kasol (Hotspring)	Kulu	364.45	37.40	Related to Shat - Chhinjra and Kasol mineralization
Maldeota	Dehradun	323.01	63.40	Related to mineralization of Mussorie syncline
Partibba	Dehradun	203.50	26.47	Related to mineralization of Mussorie syncline
Jungle Chitti	Garhwal	207.20	12.64	
Nand Prayag	Garhwal	159.10	33.40	Related to Pokhri - Tunji mineralization
Nanagal (Choe)	Siwalik	223.11	21.08	

he unity), Φ is thermal neutron dose (5×10^{15} nvt), and σ is fission reaction cross section (4.2×10^{-24} cm^2).

RESULT AND DISCUSSION

Garhwal area

The Rn content in water samples from various channels and mountain springs falling in the river Ganga varies from 47.7 to 345.2 Bq/L (Table 1). The U content in these water samples varies from 0.89 to 33.4 ppb, respectively (Table 1). Water samples from mountain springs of Devprayag (224.2 Bq/L) and river channel at Badrinath (345.2 Bq/L) have yielded exceptionally high values of radon content irrespective of their low U content values (0.89 and 2.60 ppb), respectively (Table 2). The water samples from mountain springs of Jungle Chitti and Nandprayag have yielded high values of U content 12.64 and 53.40 ppb (Table 2) which is related to the uranium mineralization in copper ore formation in Pokhri - Tunji area near Nandprayag Chamoli district (U.P.)

Dehradum area

The maximum Rn content in water samples from mountain springs of Maldeota and Paritibba areas is 323.01 and 203.5 Bq/L. respectively. The U content of these springs is found to be 63.40 and 26.47 ppb, respectively (Table 1). The anomalies in Maldeota and Partibba areas are related to the phosphorite mineralization of Mussorie syncline (Table 2).

Kulu area

The water samples in this area are collected along the Parbati Ganga stream falling in river Beas between Brahm Ganga and Bhunter. The radon and uranium contents in water samples collected from this area vary from 64.38 to 364.45 Bq/L and 0.89 to 37.40 ppb, respectively (Table 1). Anomalous values of Rn content in water samples from

mountain spring near Shat - Chhinjra and Kasol are 323.01 and 364.45 Bq/L, respectively. The U content in these 2 springs is 8.02 and 37.40 ppb, respectively (Table 2). The anomalous values of Rn and U are due to the presence of U - mineralization ia quartzite and metasediments of the area already reported by Dar (1964).

Kangra area

Rn and U content in water samples collected from this area ranges from 34 to 202.8 Bq/L and 0.20 to 2.31 ppb, respectively (Table 1). No uranium anomaly has been observed in this area.

Siwalik area

The Rn and U contents are found to vary from 105.82 to 223.11 Bq/L and 0.42 to 21.08 ppb in river Sutlej and mountain springs, respectively (Table 1). The Rn and U anomalies of 223.11 Bq/L and 21.08 ppb, respectively, are identified in the water samples from choe (rivulet) near Nangal (Table 2).

CONCLUSION

It is observed that Himalayan river system in N - W Himalayas, namely Kulu, Kangra, Garhwal and Dehradun areas, is conspicuous by its high dissolved uranium concentration as also reported by Sarin *et al.* (1992b). Generally it has been found that radon concentration follows the uranium trend in water but in some area U - Ra disequilibrium exists. The source of high radioactivity of Himalayan rivers may be attributed to the intense chemical weathering and uranium mineralisation in the source areas and along the course of the river system.

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