Radon/Helium monitoring in some natural/thermal springs of North India and Bhutan

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Geological Survey of India (GSI) reported the location of 303 thermal springs[1] in different states of India. These springs (Fig.1) are related to tectonic belts, grabens and fault zones, spread over the entire geographical area of the sub-continent[2]. Some of these springs have linkage with Indian mythology and are famous pilgrimage centers since the historical times. While people visit these springs for pleasure and remedial purposes, unconsciously they may be exposed to large dose of radioactive emissions[3] from some of these. The purpose of this study is two fold: (i) To measure radon concentration in natural and hot water springs in some of the North-Indian states, viz. Uttranchal, West Bengal and Sikkim, and Bhutan to determine the level of radioactivity, and (ii) to monitor helium concentration in some thermal springs of West Bengal, Jharkhand, Uttranchal and Himachal Pradesh for purposes of industrial exploitation.

Geochemical studies[4-7] have been carried out recently in India to determine chemistry of geothermal gases and their radioactivity. However, there is scanty data available on radon and helium concentrations in natural/thermal springs. The experimental techniques used for radon and helium concentration measurement in the liquid phase have been reported elsewhere[6]. Radon concentration has been measured in 1 litre of spring water by using scintillometry technique. Alpha Scintillometer GBH 2002 (GBH Electronic, Germany) with Lucas cell assembly was used to record alpha counts and the radon concentration is measured by using the calibration constant (10 counts = 1 Bq/L). Helium leak detector ASM 100 HDS (Alcatel, France) based on mass spectrometry and using sniffing technique was used for helium estimation in thermal springs. The whole operation is fully automatic and it can measure the helium concentration from 0.1 ppm to 100% helium.

However, for helium estimation in vapour phase, a special gas collection procedure[8] has been adopted (Fig.2). A bottle containing hot spring water is inverted over water near the orifice and a wide-mouthed funnel is kept covering over the spring orifices while introducing its stem within the inverted bottle. The gas is collected into the

bottle after displacing the water. The mouth of the sampling bottle was closed by a rubber stopper and finally sealed with beeswax. As helium diffuses through PVC rather easily, it is advisable to use borosilicate glass ampules (150ml) for helium gas collection. Thus the gases bubbling through hot spring waters were collected by downward displacement of water.

The results of radon concentration measurement are summarized in Table 1. The radon recorded its lowest value of 0.1 Bq/L in a natural spring of Bhutan. The highest value of radon (441.2Bq/L) was recorded in a natural spring at village Swastik Burtu near Gangtok in Sikkim state. It is observed that natural / thermal springs in Uttranchal record relatively low values of radon concentration, while the natural springs in and around Gangtok, in Sikkim record high radon values. In West Bengal, the highest radon concentration is reported for a thermal spring at Bakreshwar which is 34.5 Bq/L. The radon concentration measured in groundwater of Punjab[9] varies from 3.3 to 8.8 Bq/L. Due to high radon concentration in natural springs, the residents in the city and villages around Gangtok are likely to be exposed to radiation hazards due to consumption of potable spring waters.

The results of helium concentration in vapour phase are reported in Table 2. The highest value of 40,000 ppm is recorded in a thermal spring at Bakreshwar in West Bengal. It is being exploited by Saha Institute of Nuclear Physics, Kolkatta for research and commercial purposes. Another thermal spring at Tantloi in Jharkahand has helium concentration of 12,000 ppm. All other thermal springs in Uttranchal and Himachal Pradesh which attract both Indian and foreign tourists because of their scenic beauty and spiritual sanctity record low concentrations of helium. Hence these do not qualify for commercial exploitation. In fact, helium gas is a high -tech material and India needs it to run its high energy accelerators and fast breeder technology programme. Helium anomalies alongwith radon anomalies can serve as a useful earthquake precursor in India[10-11].

Since the source of helium is alpha emissions from radium and its daughters, our study reveals that there is no serious radiation health hazard to the public bathing in the open in the thermal springs of Uttranchal and Himachal Pradesh. Radon concentration is usually much higher in groundwater than in surface water and internationally

recommended[12] safe values range from 4 to 40 Bq/L for groundwater used for human consumption. Hence there is a need to store natural spring water in open tanks before its supply to Sikkimese people. It is also proposed to undertake epidemiological survey to in Sikkim to determine cancer risk to the exposed population in the area

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Table 1. Radon concentration in Thermal/Natural Springs

Sr. No.	Name of Place	Source	Radon Conc. (Bq/L)
I	**West Bengal**		
(i)	Darjeeling	Natural Spring	3.3
(ii)	Bakreshwar	Thermal Spring	34.5
(iii)	Bhuri, Raniganj	Thermal Spring	3.5
II	**Sikkim**		
(i)	Tadong 5 miles, Gangtok	Natural Spring	25.9
(ii)	Upper Chanmari 2 mile, Gangtok	Natural Spring	100.5
(iii)	Lower Chanmari, Gangtok	Natural Spring	16.1
(iv)	Zero Point, Gangtok	Natural Spring	225.4
(v)	Swastik Burtu, Gangtok	Natural Spring	441.2
(vi)	BulBule, Gangtok	Natural Spring	27.1

III	**Bhutan**		
(i)	Dyna Bridge, Samtse District	Natural Spring	0.1
(ii)	Dyna Bridge, Samtse District	Natural Spring	10.1
(iii)	Dyna Bridge, Samtse District	River Water	6.0
(iv)	Chhaja, Paro Road	Natural Spring	1.2
(v)	Khatchatabchu, Paro Road	Natural Spring	0.1
IV	**Uttaranchal**		
(i)	Suryakund, Yamunotri	Thermal Spring	0.8
(ii)	Gangnani	Thermal Spring	2.6
(iii)	Netala, Gangnani	Natural Spring	1.1
(iv)	Gauri Kund, Kedar Nath	Thermal Spring	4.4
(v)	Kund (on way to Kedar Nath)	Natural Spring	2.6
(vi)	Rudraprayag	Natural Spring	3.1

Table 2. Helium concentration in Thermal Springs

Sr. No.	Name of Place	Source	Helium Conc. (ppm)
I	**West Bengal**		
(i)	Bakreshwar	Thermal Spring	40000
(ii)	Bhuri, Raniganj	Thermal Spring	1000
II	**Jharkhand**		
(i)	Tantloi	Thermal Spring	12000
III	**Uttaranchal**		
(i)	Gangnani	Thermal Spring	100
(ii)	Yamunotri	Thermal Spring	15
(iii)	Gauri Kund, Kedar Nath	Thermal Spring	10
IV	**Himachal Pradesh**		
(i)	Gurudwara, Manikaran	Thermal Spring	200
(ii)	Shiv Mandir, Manikaran	Thermal Spring	40

(iii)	Manikaran	Bore Hole (open)	8