

must find out why this is so and what is causing this? Is it due to diet, environment or due to some other cause.

*Recently, you have stressed that medical scientists should look at why gall bladder cancer is so common in Bengal?*

Yes. It is necessary to find out the cause, whether it is due to insecticides in the food, food habits, etc.

*Do you think medical scientists should publish more? Have you set an example?*

Yes. I know it is very difficult to do research as a doctor. I was earning a lot of

money, so I spent some of my earnings to do medical research.

### General

*Common people would like to know what you are going to do about food adulteration. This is a big concern as it involves their daily food intake?*

We have held some meetings and again, being a state subject, we have to take the help of the states. Food adulteration and spurious medicines, these are the two concerns with which we are really worried.

*What about iodine deficiency?*

Yes, we are taking care of iodine deficiency disorder all over the country. And wherever we find that there is some carelessness about it, we want to supplement that area with iodine. There are pockets that need to be addressed in this manner.

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**Nirupa Sen**, 1333 Poorvanchal Complex, JNU New Campus, New Delhi 110 067, India (e-mail: nirupasen@vsnl.net).

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## SCIENTIFIC CORRESPONDENCE

# Radon and helium monitoring in some thermal springs of North India and Bhutan

The Geological Survey of India (GSI) reported the location of 303 thermal springs<sup>1</sup> in different states of India. Besides the thermal springs, there are also a number of natural cold-water springs. These springs (Figure 1) are related to tectonic belts, grabens and fault zones spread over the entire geographical area of the subcontinent<sup>2</sup>. Some of these springs have linkage with Indian mythology and are famous pilgrimage centres since historical times. While people visit these springs for pleasure and remedial purposes, unconsciously they may be exposed to a large dose of radioactive emissions<sup>3</sup> 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. Uttaranchal, West Bengal and Sikkim, and in Bhutan to determine the level of radioactivity, and (ii) to monitor helium concentration in some thermal springs of West Bengal, Jharkhand, Uttaranchal and Himachal Pradesh for purposes of industrial exploitation.

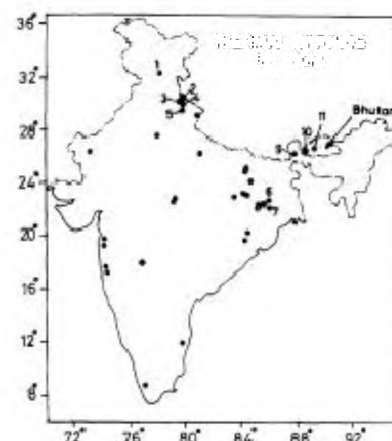
Geochemical studies<sup>4-8</sup> have been carried out recently in India to determine the chemistry of geothermal gases and their radioactivity. However, data available on radon and helium concentrations in natural and thermal springs are scanty. The experimental techniques used for

radon and helium concentration measurement in the liquid phase have been reported elsewhere<sup>7</sup>. Radon concentration has been measured in 1 l 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.

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 in Bhutan. The highest value of radon (441.2 Bq/l) was recorded in a natural spring at village Swastik Burtu near Gangtok, Sikkim. It is observed that natural as well as thermal springs in Uttaranchal record relatively low values of radon concentration, while natural springs in and around Gangtok, 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<sup>9</sup> 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 water.

It has been observed that helium is released in periodic bursts and shows both spatial and temporal variations<sup>8</sup>. The results of helium concentration in bubble gases from thermal springs are



**Figure 1.** Location of natural and thermal springs in India and Bhutan. Monitored springs are numbered: 1, Manikaran; 2, Yamunotri; 3, Gangnani; 4, Kedarnath; 5, Rudraprayag; 6, Bakreshwar; 7, Tantloi; 8, Bhuri; 9, Gangtok; 10, Samtse; and 11, Paro Road.

## SCIENTIFIC CORRESPONDENCE

**Table 1.** Radon concentration in thermal and natural springs

| Place                          | Source         | Radon concentration (Bq/l) |
|--------------------------------|----------------|----------------------------|
| West Bengal                    |                |                            |
| Darjeeling                     | Natural spring | 3.3 ± 0.6                  |
| Bakreshwar                     | Thermal spring | 34.5 ± 1.9                 |
| Bhuri, Raniganj                | Thermal spring | 3.5 ± 0.6                  |
| Sikkim                         |                |                            |
| Tadong 5 miles, Gangtok        | Natural spring | 25.9 ± 1.6                 |
| Upper Chanmari 2 mile, Gangtok | Natural spring | 100.5 ± 3.2                |
| Lower Chanmari, Gangtok        | Natural spring | 16.1 ± 1.3                 |
| Zero Point, Gangtok            | Natural spring | 225.4 ± 4.7                |
| Swastik Burtu, Gangtok         | Natural spring | 441.2 ± 6.6                |
| BulBule, Gangtok               | Natural spring | 27.1 ± 1.6                 |
| Bhutan                         |                |                            |
| Dyna Bridge, Samtse District   | Natural spring | 0.1 ± 0.1                  |
| Dyna Bridge, Samtse District   | Natural spring | 10.1 ± 1.0                 |
| Dyna Bridge, Samtse District   | River water    | 6.0 ± 0.8                  |
| Chhaja, Paro Road              | Natural spring | 1.2 ± 0.4                  |
| Khatchatabchu, Paro Road       | Natural spring | 0.1 ± 0.1                  |
| Uttaranchal                    |                |                            |
| Suryakund, Yamunotri           | Thermal spring | 0.8 ± 0.3                  |
| Gangnani                       | Thermal spring | 2.6 ± 0.5                  |
| Netala, Gangnani               | Natural spring | 1.1 ± 0.3                  |
| Gauri Kund, Kedarnath          | Thermal spring | 4.4 ± 0.7                  |
| Kund (on way to Kedarnath)     | Natural spring | 2.6 ± 0.5                  |
| Rudraprayag                    | Natural spring | 3.1 ± 0.6                  |

**Table 2.** Helium concentration in thermal springs

| Place                  | Source           | Helium concentration* (ppm) |
|------------------------|------------------|-----------------------------|
| West Bengal            |                  |                             |
| Bakreshwar             | Thermal spring   | 40,000                      |
| Bhuri, Raniganj        | Thermal spring   | 1000                        |
| Jharkhand              |                  |                             |
| Tantloi                | Thermal spring   | 12,000                      |
| Uttaranchal            |                  |                             |
| Gangnani               | Thermal spring   | 100                         |
| Yamunotri              | Thermal spring   | 15                          |
| Gauri Kund, Kedarnath  | Thermal spring   | 10                          |
| Himachal Pradesh       |                  |                             |
| Gurudwara, Manikaran   | Thermal spring   | 200                         |
| Shiv Mandir, Manikaran | Thermal spring   | 40                          |
| Manikaran              | Bore-hole (open) | 8                           |

\*Based on single spot measurements.

reported in Table 2. The highest value of 40,000 ppm is recorded in a thermal spring at Bakreshwar, West Bengal. Originally started by the Variable Energy Cyclotron Centre, Kolkata, it is now being exploited by Saha Institute of Nuclear Physics, Kolkata for research and semi-commercial purposes. Another thermal spring at Tantloi in Jharkhand has helium concentration of 12,000 ppm. All other thermal springs in Uttaranchal 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 along with radon anomalies can serve as a useful earthquake precursor in India<sup>10,11</sup>.

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 thermal springs of Uttaranchal and Himachal Pradesh. Radon concentration is usually much higher in groundwater than in surface water, and internationally recommended<sup>12</sup> 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 people.

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H. S. VIRK\*  
A. K. SHARMA  
NAVJEET SHARMA

*Department of Physics,  
Guru Nanak Dev University,  
Amritsar 143 005, India*

*\*For correspondence.  
e-mail: virkhs@yahoo.com*