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EARTHQUAKE PREDICTION STUDIES IN KANGRA VALLEY USING PLASTIC TRACK RECORDERS

BALJINDER SINGH, SURINDER SINGH and H. S. VIRK

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

ABSTRACT

Earthquake prediction is based on the precursory phenomena and radon has emerged as a useful precursor in recent years. Radon emanation in soil gas was continuously monitored at sensitive observation sites from August 1989 to December 1991 in Kangra valley of Himachal Pradesh using LR-115 type II plastic track recorder. Eleven earthquake related radon anomalies are recorded simultaneously at both the stations.

KEYWORDS

Radon; earthquake; anomaly; radon-thoron discriminator.

INTRODUCTION

Radon is produced by decay of radium in the uranium decay series and is present in trace amounts almost everywhere on the earth, being distributed in soil, groundwater and lower level of atmospherre. Anomalous radon changes in groundwater and soil-gas have been reported for other earthquakes at favourably located stations as far away as several hundred kilometers from their respective epicentres (King, 1978; Virk, 1990). The present investigations are carried out in Dharamsala (32.05°N, 76.31°E) and Chamunda devi (Dadh) (31.95°N, 76.52°E) areas of lower Himalayas in Kangra valley, to find usefulness of radon monitoring for earthquake prediction.

EXPERIMENTAL TECHNIQUE

Radon-thoron discriminator (Virk 1990) is used to measure the integrated radon concentration over weekly time period. Radon-thoron discriminator containing stripes of film is placed into shallow holes of 60 cm in depth which are then covered for protection. The films are replaced at specified intervals, are etched using 2.5N NaOH and the tracks are scanned using Carl Zeiss, Binocular Microscope.

RESULTS AND DISCUSSION

Temporal variations in soil-gas radon concentration recorded at Dharamsala and Chamunda devi are given in Figs. 1 and 2, respectively. The average value of radon concentration recorded at Dharamsala and Chamunda devi is 55.29 ± 3.0 and 13.70 ± 3.0 Bq/L with standard deviation of 38.17 and 12.94, respectively. An empirical criterion is here adopted to define the radon anomaly as the deviation that exceeds the mean radon level by more than twice the standard deviation. The first radon anomaly was recorded in second week at December, 1989 simultaneously at both the stations (Figs. 1 and 2) followed by an earthquake of 4.5M on December 23, 1989 with epicentre at 32.42°N and 76.20°E in Kangra valley of Himachal Pradesh.

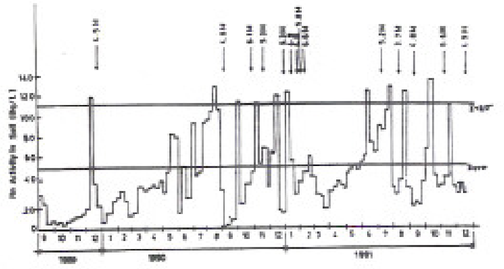

Fig. 1. Temporal variations in radon activity recorded at Dharamsala.

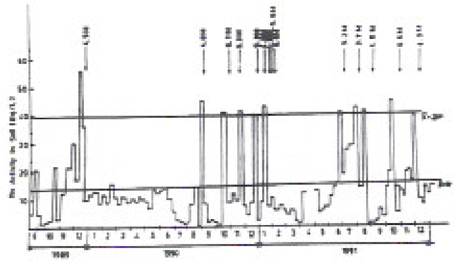

Fig. 2. Temporal variations in radon activity recorded at Chamunda devi.

In the year 1990 four anomalies were recorded at each station (Figs. 1 and 2) followed by earthquakes on September 2, 7, October 24 and November 14, 1990 each of magnitude 4.8M, 6.1M, 5.3M and 5.3M, respectively. The epicentres of these seismic events were at (36.40°N, 70.63°E), Swat valley area of Pakistan, (35.19°N, 70.63°E) and (33.30°N, 75.65°E) respectively.

In the year 1991 six radon anomalies were recorded each station (Figs. 1 and 2) followed by seismic events of 6.6M, 5.2M, 3.7M, 4.8M, 6.6M and 4.9M, respectively. The epicentre of these seismic events were at (36.41°N, 70.23°E), (32.32°N, 76.68°E), (32.21°N, 76.42°E), (36.41°N, 70.73°E), 30.73°N, 78.80°E) and (36.39°N, 69.30°E) respectively.

The increase in radon content is connected with the amount of cracking of rocks and therefore is sharply increased and then decreased due to microcracks and closure of small cracks. The observed radon pattern during the earthquake events are similar and may be explained with Institute of Earthquake Physics model (Mjachkin et al., 1975).

CONCLUSIONS

The recording stations at Dharamsala and Chamunda devi are sensitive to earthquakes of magnitude 3.7 and which occurred in the valley, as well as earthquakes of magnitude greater than 4.5 in Hindukush area (600 km away) from recording stations. The simultaneous recording of radon anomalies at two different stations is a strong indicator of the physical basis of earthquake prediction.

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