RADON SIGNALS FOR EARTHQUAKE PREDICTION AND GEOLOGICAL PROSPECTION

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SUMMARY: Recent work carried out at PINSTECH and elsewhere shows that radon signals can be used to predict the arrival of an earthquake and to locate oil, geothermal energy sources, and uranium deposits. The SSNTD-Laboratory (PINSTECH) is presently exploiting it for uranium it for uranium exploration in Pakistan and is developing an earthquake warning signal system using Solid State Nuclear Track Detectors (SSNTD).

Key Words: Radon signals, earthquake prediction, oil and geothermal energy sources, uranium deposits.

RADON SIGNALS: AN INTRODUCTION

Radon, an inert gas, is produced in the decay series of U-238 (1). The total uranium content of the earth crust is about 3-4 ppm (parts per million) which is significant in terms of total mass and its radiological contribution to our atmosphere. One can visualize from this situation that earth as a whole and uranium mines in particular case are sources of radon gas and its various radioactive daughters. Radon is the main source of radioactivity in earth's atmosphere. Radon and its daughters have been found to be mainly responsible for lung cancer not only among the uranium miners but also among the general public (1).

In addition to the serious health hazards related to radon, God has bestowed on it very unique and special properties by which it acts as a great friends (1, 2). It can be used to predict the arrival of an earthquake (3-6) to locate uranium deposits (7, 8) and oil (9-12). This is because radon is a radioactive gas and it can be traced by detecting alpha particles emitted during the decay of radon and its daughters. It can be achieved by using alpha sensitive solid state nuclear track deterctors or some other suitable detectors (1).

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Based on this special property of radon, the SSNTD-Laboratory (PINSTECH) is presently exploiting it for uranium exploration in Pakistan and is developing an earthquake warning signal system. The system is being developed by means of 'Track Detectors', which are insulating materials such as plastics, glasses and minerals. These are capable of recording latent damage trails or tracks created by positively charged alpha particles emitted by radon gas. The tracks are in fact the 'Foot Prints' of alpha particles, emitted in the decay of radon and its daughters. Initially, the tracks are very small in size but can be easily enlarged by chemical treatment for study under an ordinary optical microscope.

EARTHQUAKE PREDICTION

An important application of radon measurements is in earthquake prediction (3-6). The earthquakes have always been a source of terror and destruction for the mankind. About 3.5 million deaths are known to have occurred in 38 major earthquakes from 342-1976 A.D. The earthquake prediction has always been a dream and now it seems to be at the verge of reality as a result of advances made in the science of radon measurement.

Certain phenomena have been found to be associated with earthquakes. These include (1) the cyclic occurrences of earthquakes, (2) strike of earthquake during full/new moon periods, (3) movement of liquids and gases within the earth before the arrival of an earthquake, (4) change in water/oil levels in wells, (5) change in electro-magnetic properties of the earth, (6) change in gravitational/magnetic attaraction, (7) unusual weather and, (8) strange behavior of certain animals and human beings. All of these are precursorey phenomena but only a few have a scientific basis. The last decade or so has seen a remarkable progress in tracing a precursor for the prediction of an earthquake (3-6). Work carried out in this direction was based upon the assumption that significant changes take place in the emission of gases such as radon and trapped in the earth crust before the arrival of a 'physical jolt' of an earthquake. This change takes place because of the physical stresses which are built up within the earth crust to triger an earthquake. Work so far done has indicated the existence of a relationship between earthquake producing processes and radon movement. It has been noted that variation in radon levels is related to the intensity of an approaching earthquake.

The radon signal measurement is performed by using the track detectors fitted in tubes. The SSNTD-Laboratory of PINSTECH has been actively engaged in establishing this method of earthquake prediction on scientific basis. Some of earthquake monitoring stations have been established where tubes containing SSNTDs are burried and retrieved on regular basis. The radon signals are being monitored regularly and it is hoped to develop an earthquake warning signal system. During the past, the SSNTD-Laboratory (PINSTECH) has observed simultaneous occurrences of radon changes and earthquakes in two instances. The work so far done shows that the method is promising, although a lot more work is yet to be carried out. Technical collaboration in this regard is being finalized between the SSNTD-Laboratory (PINSTECH) and international research laboratories carrying out work in this field.

GEOLOGICAL PROSPECTION

The energy resources now available as fossil fuels for our expanding industrial programmes and improved living standards are hardly sufficient for the nex few decades. The supply of these fuels is also becoming tedious as easily workable deposits are being exhausted gradually. The only alternative left with us is to exploit 'nuclear fuel' which is adequately present as' uranium mineralization' in the earth crust. One can visualize the amount of enormous energy which uranium possesses, from the fact that one pound of U-235 produces heat energy equivalent to 1500 tons of coal.

The conventional exploration techniques like surveys with gamma sensitive instruments are not only expensive and time consuming but are also ineffective when targets are deep, mineralization is young or when a remobilization of ore has taken place. On the other hand, methods based on radon measurement provide a potential opportunity to locate uranium deposits burried several hundred meters deep without involving expensive equipment, time and much finance (7, 8).

Radon is an inert gas having a significant half life of 3.825 days and soon after it is generated deep in the earth crust, it starts traveling up and manages to reach earth surface. This character of radon helps us to locate subsurface uranium ores by means of track detection technique (1,7,8). The method consists of installation of these detectors, positioned in steel tubes over a predecided grid pattern in a suspected area. The tubes are about 15 cm long having 2.5 cm diameter with one end closed. They are burried in a 30-40 cm deep hole for 3-4 weeks. During this period, radon gas from deep uranium source (if present) is collected inside the tube and produces tracks on the track detectors due to its alpha emission. After 3-4 weeks' time, the detectors are removed, etched and studied under an optical microscope for track counting. On the basis of track density, the area which underlies an ore body can be delineated (1,7,8).

RADON HELPS IN OIL EXPLORATION

Radon gas travels deep into earth crust and is trapped by fluids such as oil (9-12). It migrates due to different type of fluid movements and under favorable circumstances, it is brought to the earth's surface (9-12). Recently, experiments were carried out in the USA for finding the correlation between radon anomalies and the oil deposits. Investigations based on measurements carried out over a period of two months or so in Oklohoma (USA) indicated a strong correlation between the oil reserves and the intensity of radon signals (9). Similar successes have been reported at some other sites of USA. More work is required to be carried out for making the correlation between the radon emanation and the amounts of hydrocarbon deposits (1).

LOCATING GEOTHERMAL ENERGY SOURCES

A geothermal source may be defined as the natural heat of the earth trapped close enough to the earth's surface to be extracted economically. Normally, geothermal sources are associated with volcenic regions. Hot water springs and vapours emanation may suggest prospecting geothermal energy sources. Extensive geophysical and geochemical surverys are needed to define the geothermal anomalies. Useful methods employed for finding promising geothermal regions include measurement of heat flow in shallow holes and deep well drilling for flow testing. After finding an evidence for a worth white geothermal source, step out wells are required to be drilled in order to determine the extent of the source. Methods such as flow testing, core analysis and evaluation techniques are employed to determine the capacity of the reservoir. Since drilling of deep wells is extremely expensive, drilling targets have to be carefully chosen. Useful information determining the potential drilling targets can be obtained by carrying out radon mapping of the area of interest. In principle, radon burried deep into the earth crust finds an easy passage to reach the top surface through geological faults normally associated with geothermal sources (13). Strong radon anomallies involcanic regions may indicate the presence of geological faults in geothermal fields. Of course, it is not that simple to indicate whether a geological fault (or part of it) is active to geothermal fluid or not. Another source of a strong radon signal may be the deposits of uranium or thorium, as already mentioned. Since radon is an alpha emitter, its presence can be detected by using alpha sensitive detectors such as plastic track detectors. This method of using radon signal for locating geothermal energy sources has met some success in countries such as Newzealand, Mexico and USA (1, 13).

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