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MEASUREMENT OF THE CONCENTRATIONS OF FLUORINE IN THE SOIL OF DIFFERENT AREAS OF SAVAR AND ITS EFFECTS ON ENVIRONMENT

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ABSTRACT

To find out the concentration of Fluorine, soil samples were collected from ten different agricultural lands of different places of Savar which were measured by using proton induced gamma rays emission (PIGE) technique. The samples were irradiated by 2.5MeV proton beam from 3MV Van de Graaff accelerator of Bangladesh Atomic Energy Commission (BAEC). Characteristic gamma rays emitted from the exited nuclei of fluorine in the samples were detected by using a high purity germanium (HPGe) detector. Concentrations of the element were measured by PIGE gamma yields with that of USGS geological standards, AGV-1 and Soil-7. The present investigation showed that the concentrations of fluorine in a few samples were under optimum range and most of them were outside of the optimum range; *i.e.*, 200ppm-300ppm. The average concentration of fluorine in the soils of Savar was 787.25ppm which was more than twice its optimum concentration of it in soil. This extra fluorine might be the result of unwise waste management of different industries and laboratories which are located in that area. The concentrations in the soils were compared with that of standard and discussed in both biological and environmental contexts.

Key words: Fluorine, PIGE Technique, Environment

I. INTRODUCTION

Fluorine is a widely distributed element and a member of the halogen family. It is naturally found in the rocks, coal, clay, and soil. In air it is found in the form of hydro fluoride gas[1,4]. During rainy season this gas mixes with water and turns into hydrofluoric acid. In water it reacts with some of the other elements present in water and turns into salts and gets deposited on the soil as sediments. Some times approximately 1ppm fluorine in the form of fluorides is added to drinking water supplies. In turn this added fluorine increases its concentration in soil[1]. Use of fluorine in toothpaste also increases its concentration in the soil around the mega cities [2]. Use of fluorine and its compound in pharmaceutical industries, ceramic factories, nuclear power plants etc. is a major cause of its increase in concentration in the soil around these installations [1,2]. This high concentration of fluorine affects all of the life forms in the soil. So periodically measurement and control of the

concentration of fluorine is very important to avoid both biological and environmental damage [3].

Several analytical techniques are used to measure the concentration of trace elements like fluorine, chlorine, bromine etc. PIGE technique is suitable for the measurement of the concentration of fluorine because of its low atomic number. This method is based on the prompt gamma rays emitted from exited nuclei of the elements following the charged particle irradiation of the sample [4].

II. METHODOLOGY OF PIGE ANALYSIS

Sample Collection and Preparation:

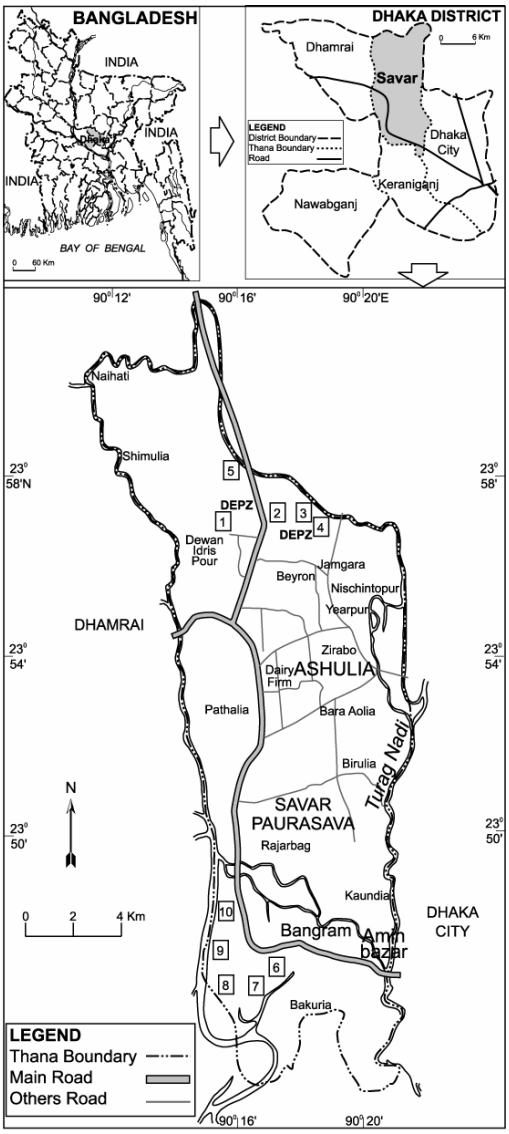
The soil samples were collected from different agricultural lands of Savar which are flooded in the rainy season and remain dry in the summer. The soil is affected by the industries and factories like brick fields, ceramic industries, pharmaceutical industries, textile mills etc. The samples were dried in an oven at a temperature below 60^{o}C for about 10 hours [5]. Soil samples were collected from ten different spots of the study area (Table-1 and Map-1). After cooling the samples to room temperature in a dessicator, the weights were taken. The weighed samples were then ground in the grinder and made into pellets with a pellet maker. These pellets were used as the targets for irradiation with proton beam.

Table-1: Location and Sample Identification

Name of the Location	Sample No.
Purba Para (Ganok Bari)	Soil-1
BEPZ (Ganok Bari)	Soil-2
Goal Tack-1	Soil-3
Goal Tack -2	Soil-4
Shiripur	Soil-5
Tal Tack-1	Soil-6
Tal Tack-2	Soil-7
Fulbaria-1	Soil-8
Fulbaria-2	Soil-9
Haran Nagar	Soil-10

Instrumentation:

Figure-1 shows the schematic diagram of the internal /external beam PIGE setup. Two tantalum collimators, each of 2 mm diameter, and a 4 mm cleanup aperture, were used to obtain a finely collimated beam.



Map - 1 : The Study Area and Location of Sample Spots

In internal beam PIGE, sample excitation and gamma-ray emission are performed within the vacuum chamber. In the external beam technique, samples are irradiated in air, where a wide variety of samples can be irradiated easily for extracting the proton beam through the Kapton.

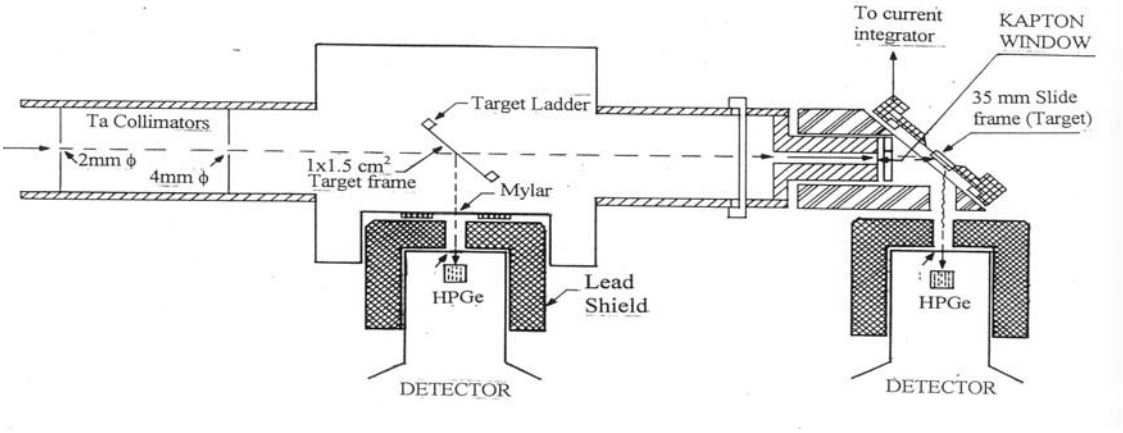


Figure-1 : Schematic Diagram of the External/Internal Beam of PIGE

A high purity germanium (HPGe) detector[7] in the first position is used for gamma ray analysis in the case of internal beam technique window strong enough to hold vacuum in the accelerator tube. The great advantage of the external beam technique is the reduction of charge built up on the sample during irradiation [4,5]. Polyimide films (Kapton brand) of 1.12 mg/cm^2 thickness were used to extract the proton beams from the beam port into the air. The setup was used to extract the proton beam port into the air. The set up is designed to hold a 35 mm slide frame for solid samples at an angle of 45^o relative to the beam direction, and the characteristic γ-rays are detected at 90^o with respect to the beam. The total proton charge on the sample and Kapton window, from the beam port and the collimators, was integrated with charge integrator: The external beam is most useful for irradiation of samples of different shapes and sizes. Because of limitations in geometry, internal beam irradiation is more restrictive.

In this measurement analyzed proton beam energy was 2.9 MeV. The proton energy on the target after absorption at the exit window and the air between the window and the sample is estimated to be 2.5MeV. Each sample was irradiated for a preset charge of 100μC with a beam intensity of 10-15nA.

Data Acquisition:

The schematic diagram of the data acquisition set up used in PIGE analysis is shown in Figure-2. The inelastic scattering of protons on fluorine leads to the emission of characteristic γ-rays from the nucleus of the samples. The characteristic γ-rays coming out from the samples were detected with a high purity germanium (HPGe) detector having a resolution of 1.75 keV at 1332 keV. A standard multi channel analyzer[8] was used for data acquisition and analysis. A typical PIGE spectrum of a soil sample is illustrated in Figure-3. The γ-ray spectrum was analyzed using a commercially available γ-rays unfolding software obtained from APTEC[9] Nuclear Inc. USA.

In the typical PIGE spectrum two γ-rays peaks at energy 110keV and 197keV represent fluorine lines because the inelastic scattering of protons on ^{19}F leads to the emission of gamma rays from the first and second excited states of ^{19}F nucleus with energies of 110 and 197 keV, which have a very high production cross sections that do not interfere with other γ-rays. These γ lines can also be produced in the ^{18}O(p, γ)^{19}F reaction, but because of the relative low abundance (0.2%) and low proton interaction cross section of ^{18}O, the contribution from this reaction can be ignored without much error[4,6].

III. RESULTS AND DISCUSSIONS

Using PIGE technique the concentrations of fluorine of 10 soil samples were analyzed [6,12] and shown in Table-2. In this measurement the minimum detection limit[11] of fluorine was 22.13ppm whereas the minimum concentration of fluorine was found 63.12ppm in the study area. These concentrations had also been compared with that of the standard in soil, 200 ppm-300ppm[10].

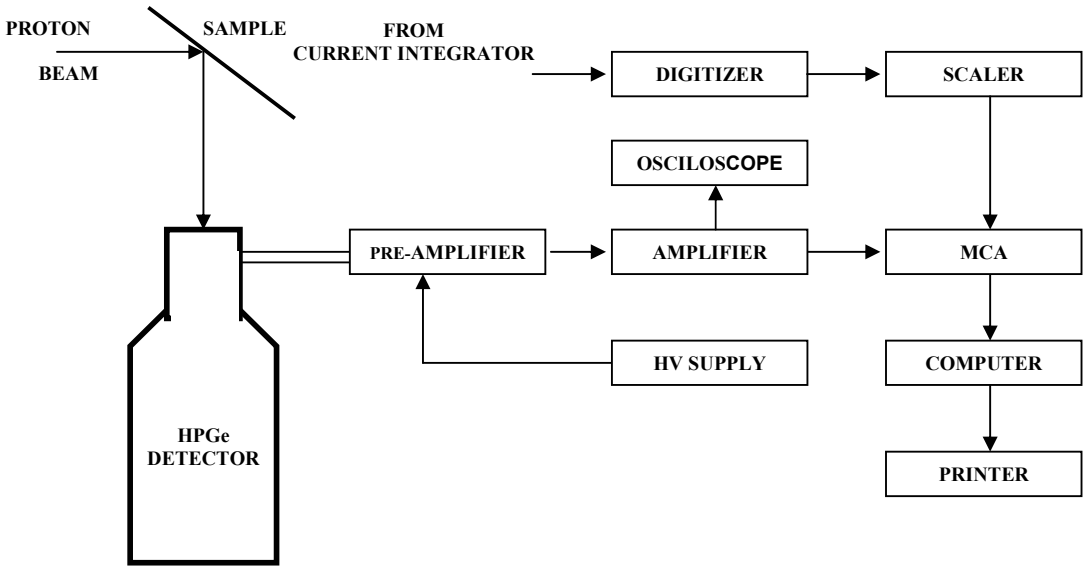


Figure-2 PIGE Data Acquisition

Table-2 Concentration of Fluorine in 10 Soil Samples

Sample No.	Concentration of fluorine in ppm	Mean deviation with respect to 300 ppm
Soil -1	740.14	44.02
Soil -2	848.54	54.85
Soil -3	63.12	-23.69
Soil -4	1411.72	111.17
Soil -5	1604.34	130.43
Soil -6	311.39	1.14
Soil -7	732.14	43.11
Soil -8	761.14	46.11
Soil -9	700.25	40.03
Soil -10	670.70	37.07

Table-2 depicts that the concentrations of fluorine in a few samples are under optimum range and most of them are outside of the optimum range; *i.e.*, 200ppm-300ppm. The average concentration of fluorine in the soils of Savar is 787.25ppm which is more than twice its optimum concentration in soil. Since the samples were collected from agricultural lands very near to the industrial areas where different pharmaceutical laboratories, brick fields, ceramic industries, soap factories etc are situated, the extra fluorine may be the result of unwise waste management of those industries and laboratories.

The microorganism, plants, and animals that exist in the biotic environment would be affected in the long run due to this high concentration of fluorine

High concentration of fluorine will also affect the ecosystem of the study area which may bring heavy sufferings for the inhabitants of the area for a long span of time. Microorganisms, insects and even the birds and reptiles would be affected resulting in various diseases.

Grasses, vegetables and plants deposit a huge amount of fluorine and animals depending on these suffer from different musculoskeletal diseases, heart diseases, bone fractures, stomachaches, kidney and lunge damages.

IV. CONCLUSION

Since fluorine toxicity has harmful effects on microorganisms, insects, plants and animals, its concentration should always be routinely measured to keep the concentration within the optimum range.

The optimum range of fluorine in soil is from 200ppm to 300ppm, and in water it is 0.7 mg/L to 1.2 mg/L; while in air it is 0.2mg/m^3 to 2.0 mg/m^3 [10]. By maintaining the concentrations within the optimum range, different fluorine originated diseases can be avoided.

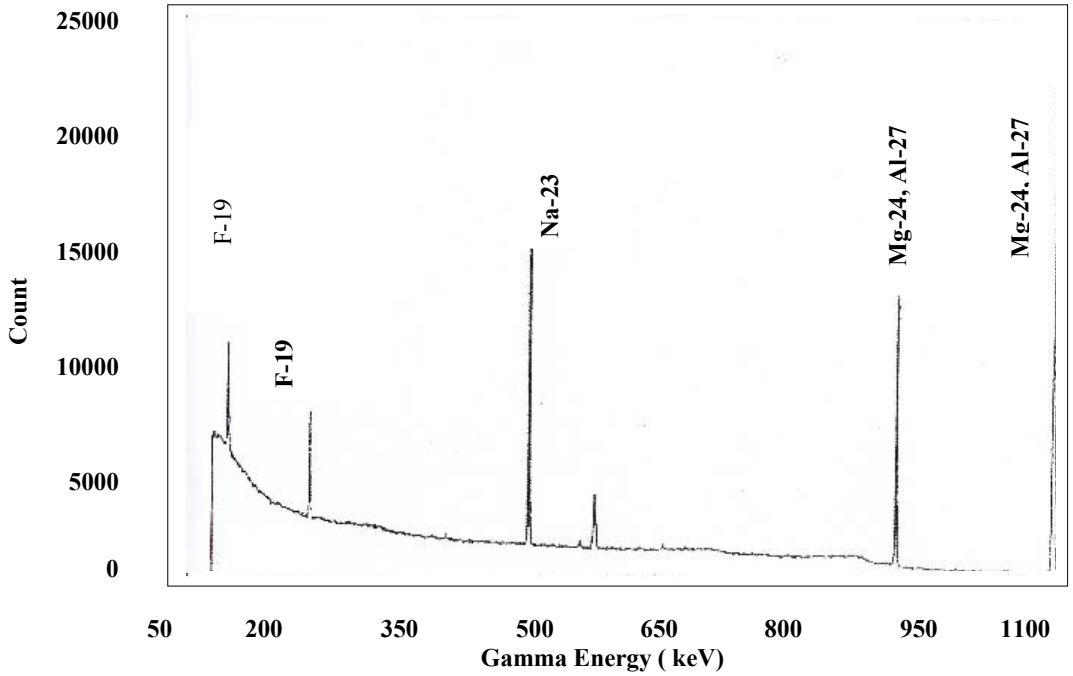


Figure-3 A Typical PIGE Spectrum

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