Quantitative Analysis of soil samples using PIGE technique

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Introduction

The major part of the earthôs crust consists of light elements. The important micronutrients in the soil such as fluorine, boron, lithium, sodium, etc play a vital role in our life. The depletion of the soil nutrients and its effect on the productivity is one of the major concerns in the world today. The Knowledge of the elemental contents of the soil is important because soil is the most important source of minerals for both human being and plants. Many diseases are caused due to the imbalance of supply of the mineral needs.

Proton-induced ɔï ray emission(PIGE) is an analytical technique based upon the measurement of ɔï rays emitted from a sample, irradiated with the energetic ions from an accelerator[1].In PIGE an excited nucleus is produced by a nuclear reaction normally by (p,p'ɔ), (p,nɔ) or (p,Ŭb) reaction. The ɔï ray emitted in the de-excitation is detected and the isotope can be identified from the ɔï ray energy. In the present work, the PIGE reactions ^{19}F (p,p^{Ni}Ɔ)^{19}F and ^{23}Na(p,p^{Ni}Ɔ)^{23}Na were used for the determination of yields and hence the concentrations and sensitivities for the elements F and Na.Concentrations of Na and F were found at a slightly toxic level in some soil samples.

Experimental Set-up

A 3 MeV proton beam with a current of ~10 nA was used to bombard the samples. Proton beam was produced from Single Dee Cyclotron situated at the Punjab University, Chandigarh, India [2]. The beam size at the target position was 2 mm in diameter. The target was positioned at 90° w.r.t. the beam direction and the characteristic ɔ-rays emitted from the samples were detected by an ORTEC HPGe detector (FWHM 1.9 KeV at 1.173MeV) at 135° to the beam line.

Data analysis and results

For the quantitative PIGE analysis, the unknown concentration for the specific element *a* in the analyzed sample is calculated using the following equation:

$$C_{samp,a} = C_{ref,a} \frac{Y_{samp}(E_o) S_{samp}(E_o)}{Y_{ref}(E_o) S_{ref}(E_o)}$$

Where Y_{samp} and Y_{ref} are the yields of the measured ɔï ray for the sample and reference material, respectively at proton energy E_o. S_{samp} *and* S_{ref} *are* the stopping powers calculated for the sample and the reference material, respectively, at proton energy E_o For the Normalization of the set-up, standard pellets of NaF salt mixed with graphite were prepared and normalization curves for Fluorine and Sodium were drawn from the measured yields. Fig.1 and Fig.2 show the Normalization curves for F-19 and Na-23 respectively. Fig.3 shows the spectrum of a soil sample taken from one of the regions under study and Table.1 shows the experimental results for elemental concentrations present in these samples.

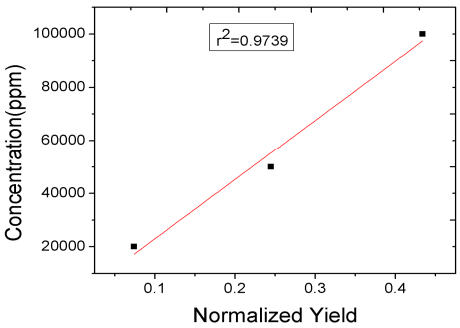

Fig.1 Normalization curve for Fluorine

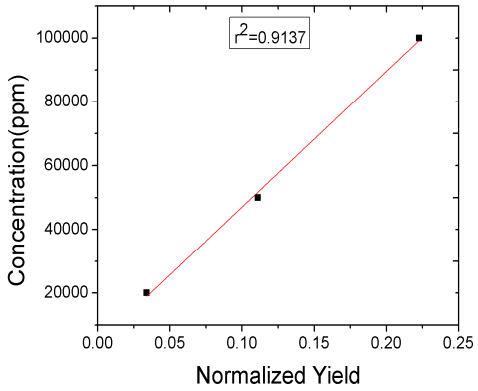

Fig.2 Normalization Curve for Sodium

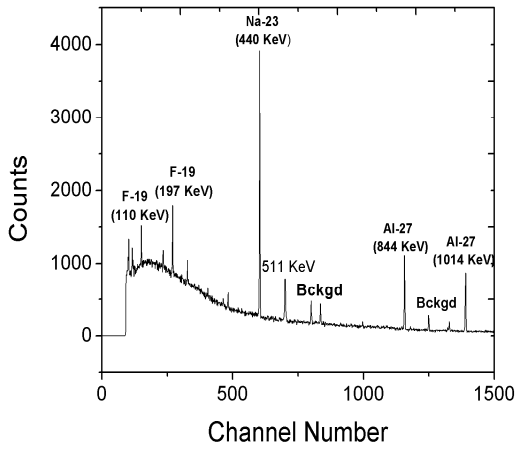

Fig.3 Spectrum of a soil sample

Table1: Results for elemental concentrations

Sample No.	F-19 (ppm)	Na-23 (ppm)
Soil 1	869±22	12397±124
Soil 2	845±20	10076±105
Soil 3	657±28	7445±140
Soil 4	587±17	5956±80
Soil 5	375±16	5851±90
Soil 6	535±21	5857±103
Soil 7	352±17	6950±111
Soil 8	692±22	5112±86
Soil 9	576±20	6949±69

Where Soil1(Karanpur Vill), Soil2(Model Town Pinjore), Soil3(MirzapurDam), Soil4(Indo global Coll.),Soil5(BaddiIndus.Township), Soil6(Siswandam),Soil7(Haripur vill),Soil8(HMT),Soil9(Kiratpur vill.) .

Conclusion

The Na content of the 9 samples lies in the range 5500ppm-130000ppm whereas the optimum Na content for the soil is 6300ppm. Some of the soil samples in this region appear to be toxic in Na and are not suitable for animals and plants. The F content of the 9 soil samples collected from these regions lies in the range 300ppm -900ppm whereas the optimum content in the soil is 480ppm. Fluorine has attracted much attention in recent years because of the apparent role it plays in health of human beings. Fluoride ions are readily absorbed by plants, especially from the more acid types of soils, but in any appreciable concentration they are highly toxic. The results of concentration measurements of F and Na on arable soil samples using PIGE technique though reliable are not however comprehensive enough to draw any definite conclusion about the toxicity or deficiency of these elements. In this work, our aim is to measure the trace elements in drinking water and soil in the Punjab region where people are facing serious health problems due to toxic elements present in soil and water. Therefore, Comprehensive elemental analysis of the soil and water of these regions are being carried out so that maps of these regions can be constructed showing their concentrations and the results will be presented in the Symposium.

References:

[1]J.R.Bird, J.S.Williams, Ion Beams for Material Analysis, academic Press, Australia. 1989, p.719.

[2]N.K. Puri, P. Balouria, I.M. Govil, B.P. Mohanty and M.L. Garg, *Int. J. PIXE* **16** (1 and 2) (2006), pp. 7ï 20.