Determination of Essential Elements in (Toty, Sardia) Soil Using X-Ray Fluorescence

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Abstract

In this work soil analysis was using energy dispersive x-ray fluorescence spectrometer (EDX3600B) to determine the essential elements in soil due to their vital value in human body, animals and plants. Sample A1, A2, A3 which is collected from Khartoum, Sudan (Toty island) and sample B1, B2, B3 collected from Shandy, Sudan (Sardia island). All soil samples have the same crop (tomatoes). The analysis was done in Skyray Instrument International company In China under air condition and vacuum condition.

The results showed that Sample A contains elements Mg, Al, Si, K, Ca, Ti, Cr, Mn, Fe, Sr, Zr; and it may contain elements Na, P, S, Cu, Rb, Y, Nb.

And Sample B contains elements Mg, Al, Si, K, Ca, Ti, Cr, Mn, Fe, Sr, Zr; and it may contain elements Na, P, S, Ni, Cu, Rb, Y, Nb.

Introduction

1.Common Types of Spectroscopy

Fluorescence Spectroscopy

Fluorescence spectroscopy uses higher energy photons to excite a sample, which will then emit lower energy photons. This technique has become popular for its biochemical and medical applications, and can be used for confocal microscopy, fluorescence resonance energy transfer, and fluorescence lifetime imaging [1] .

X-Ray Spectroscopy And X-Ray Crystallography

When X-rays of sufficient frequency (energy) interact with a substance, inner shell electrons in the atom are excited to outer empty orbitals, or they may be removed completely, ionizing the atom. The inner shell "hole" will then be filled by electrons from outer orbitals. The energy available in this de-excitation process is emitted as radiation (fluorescence) or will remove other less-bound electrons from the atom (Auger effect). The absorption or emission frequencies (energies) are characteristic of the specific atom. X-ray absorption and emission spectroscopy is used in chemistry and material sciences to determine elemental composition and chemical bonding. X-ray crystallography is a scattering process; crystalline materials scatter X-rays at well-defined angles. If the wavelength of the incident X-rays is known, this allows calculation of the distances between planes of atoms within the crystal. The intensities of the scattered X-rays give information about the atomic positions and allow the arrangement of the atoms within the crystal structure to be calculated [2].

Other Types Of Spectroscopy

Flame Spectroscopy, Auger electron spectroscopy, Mössbauer spectroscopy, Photoemission spectroscopy (PES),Nuclear magnetic resonance spectroscopy [NMR spectroscopy], Spark or arc (emission) spectroscopy, Direct-current plasma (DCP) [3] .

2.The Soil Ecosystem

Understanding the role of the soil in the farm ecosystem, and knowing how to manage the land, are critical and difficult tasks facing the organic farmer. The soil's biological and electrochemical processes cannot be observed directly since they take place at a microscopic and sub-molecular level. Changes in fertility, tilth and structure may take years to become evident. Early indicators are subtle, and the farmer must be a keen observer to spot them. Here I explain the biological, chemical and physical properties of the soil as a background to sound management. Much of the material will be familiar; the key difference is the recognition of the vital role soil micro-organisms play in recycling, releasing, and storing plant nutrients. Organic farmers use techniques that support and enhance the biological life of the soil, which in turn nurtures the crop and maintains soil structure [4].

Soil Biology

Billions of organisms inhabit the upper layers of the soil, where they break down dead organic matter, releasing the nutrients necessary for plant growth. The micro-organisms include bacteria, actinomycetes, algae and fungi. Macro-organisms include earthworms and. arthropods such as insects, mites and millipedes [5].

Cation-Exchange Capacity

Plants obtain many of their nutrients from soil by an electrochemical process called cation exchange. it requires very small particles with a large surface area to hold electrically-charged ions

Elements Cycles

- ***Nitrogen Cycle***

  The vegetative growth of plants (leaves, stems, and roots) is especially dependent on nitrogen. Plants cannot use gaseous nitrogen, but require nitrogen in the form of nitrate (NO_3^-) or ammonium (NH_4^+). Atmospheric nitrogen is converted into NO_3^- and NH_4^+ in the soil by nitrogen fixation, which is performed by certain soil micro-organisms.

- ***Carbon Cycle***

  Plants obtain carbon from atmospheric carbon dioxide (CO_2) through photosynthesis, during which the chloroplasts in the plant cells convert CO_2 to carbohydrates. It is the cycling of carbon from the atmosphere through plants and algae, to animals and micro-organisms and back to the atmosphere, the carbon: nitrogen (C: N) ratio of the organic matter supplied to the soil is a controlling factor in this process. A ratio of about 20:1 is considered ideal

- ***Phosphorus Cycle***

  It is a difficult nutrient to manage because, although abundant in the soil, it is often in a form unavailable to plants. In acidic soils (pH below 5) the phosphorus gets tied up with iron and aluminum, and in alkaline soils (pH above 7) it gets tied up with calcium. Even with a favorable pH, phosphorus readily becomes immobilized by other soil minerals, Phosphorus availability is therefore dependent on the maintenance of high levels of biological activity and stable humus in the soil

- ***Potassium Cycle***

  Soil potassium is present in minerals that dissolve slowly, thereby limiting its availability. Potassium availability is regulated by cation exchange. Increased biological activity and colloidal humus formation will increase potassium availability by enhancing the CEC in the soil

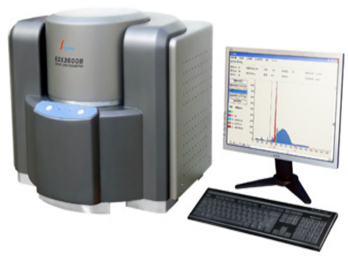
Micronutrients

To supply the soil with microelement (trace element) if certain micronutrients exceed trace levels, they can be toxic to plants. The range between deficiency and excess is very small. Therefore, micronutrients should not be applied unless a deficiency is shown by leaf analysis or by visible plant symptoms [6].

Material & Methods

The Instrument Used

Energy Dispersive X-Ray Fluorescence Spectrometer (EDX3600B) with vacuum sample chamber and automatic lifter monitoring systems used to analysis the samples the figure shown below



EDX3600B

Testing Report

The Sample

The samples are agricultural Soil collected from two places, the first group is samples A_1 A_2 and A_3 which are collected from Khartoum (Toty island) and the second group is samples B_1 B_2 and B_3 which are collected from Shandy (Sardia island) by using GPS 76 to determine the length and width lines

Sample Preparation

The sample was taken as powdered and to be examined under the XRF it was forced to solid dick by pressing machine, the different samples was prepared and taken to the test.

Test procedure

The sample was put under the cover of the XRF instrument facing the X-Ray source and the detector was put by an angle to the sample and the detector was connected to the multi-channel analyzer. So, the results were obtained from the spectrum and the characteristic X-Ray energy table**.**

Results and Discussion

1.Toty Island Samples (A_1, A_2, A_3)

Results of Testing Under Vacuum Condition

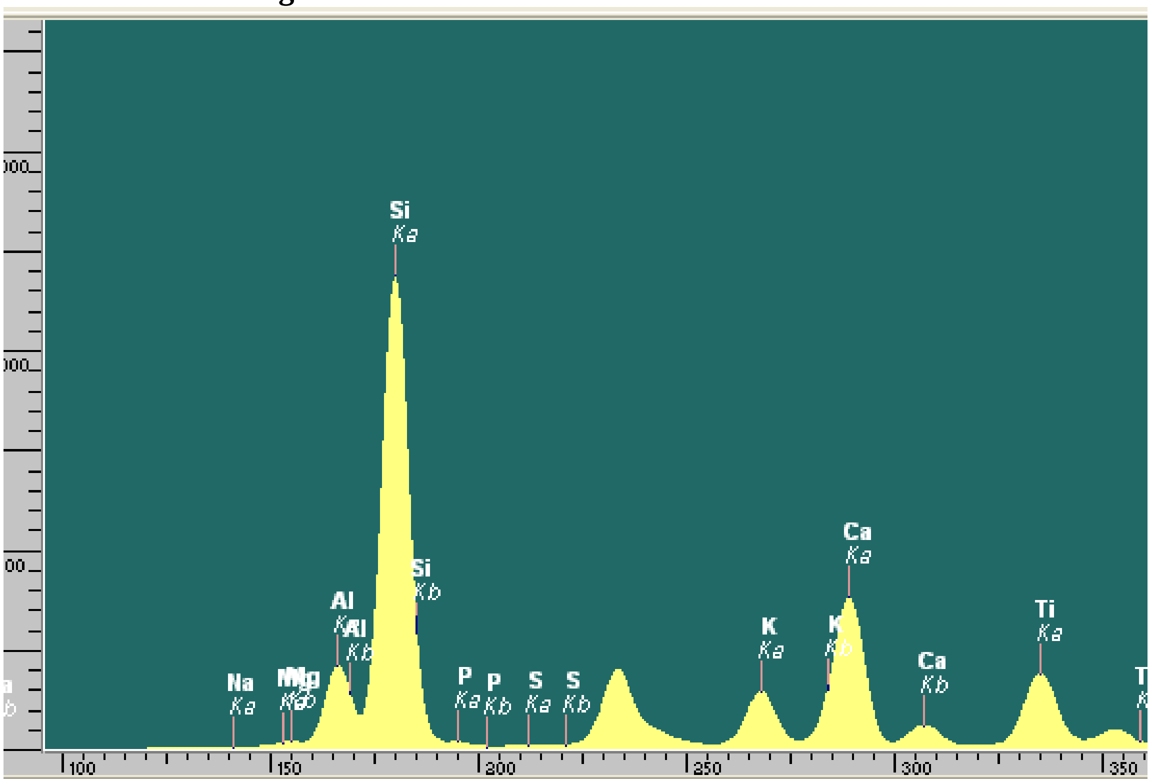


Fig (1.1) Spectrum of First part of Sample A 1
Location Lines: N 15^{o} 37$^{\backslash}$ 57.79$^{\backslash\backslash}$ E 32^{o} 29$^{\backslash}$ 57.80$^{\backslash\backslash}$

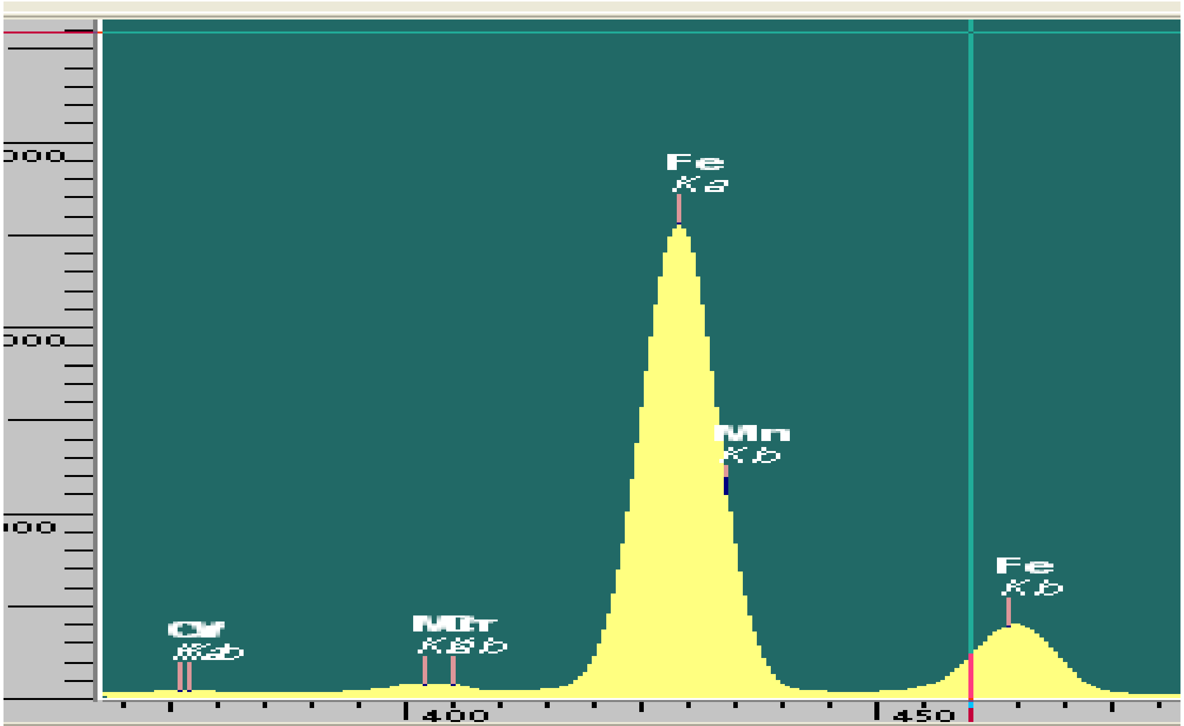


Fig (1.2) Spectrum of Second part of Sample A 1
Location Lines: N 15° 37′ 57.79″ E 32° 29′ 57.80″

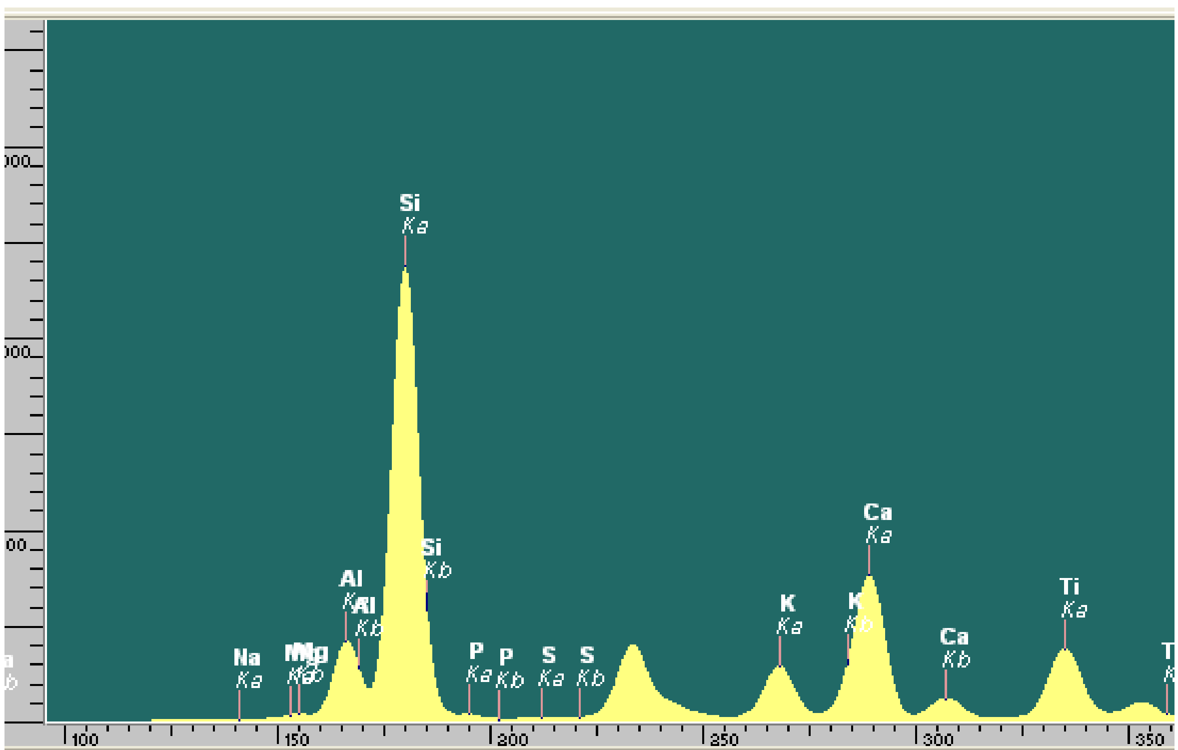


Fig (1.3) Spectrum of First part of Sample A 2
Location Lines: N 15° 37′ 57.96″ E 32° 29′ 59.02″

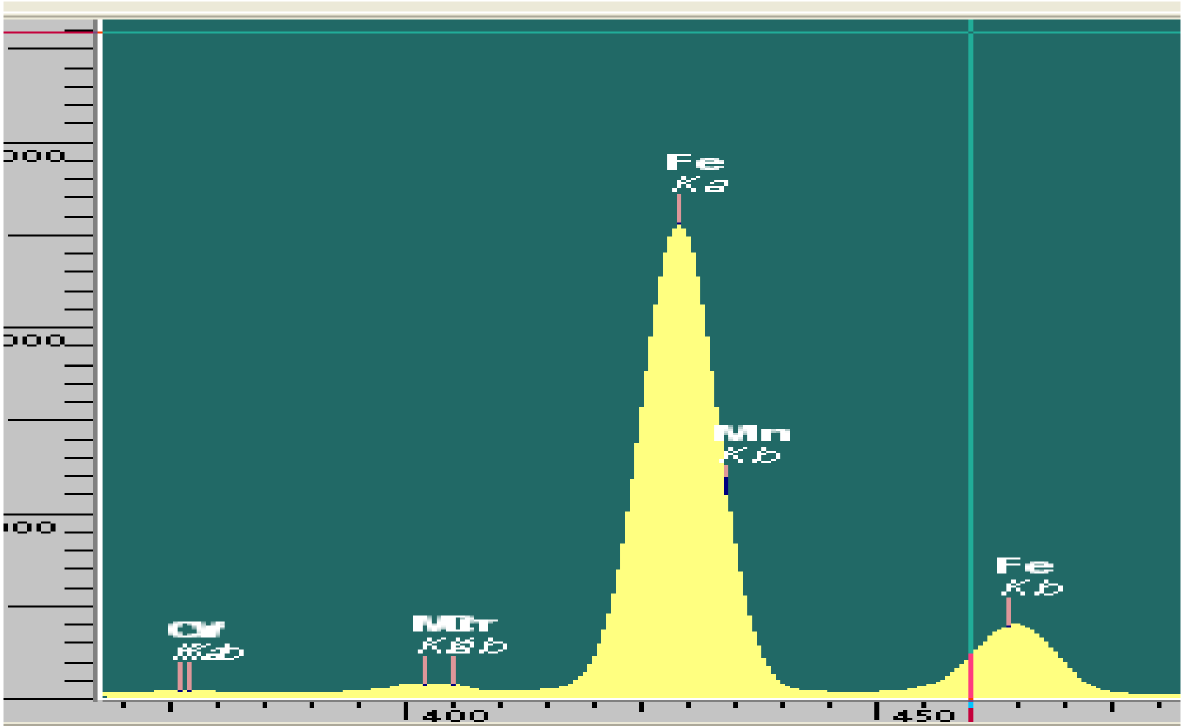


Fig (1.4) Spectrum of Second part of Sample A 2
Location Lines: N 15^{o} 37\ 57.96\\ E 32^{o} 29\ 59.02

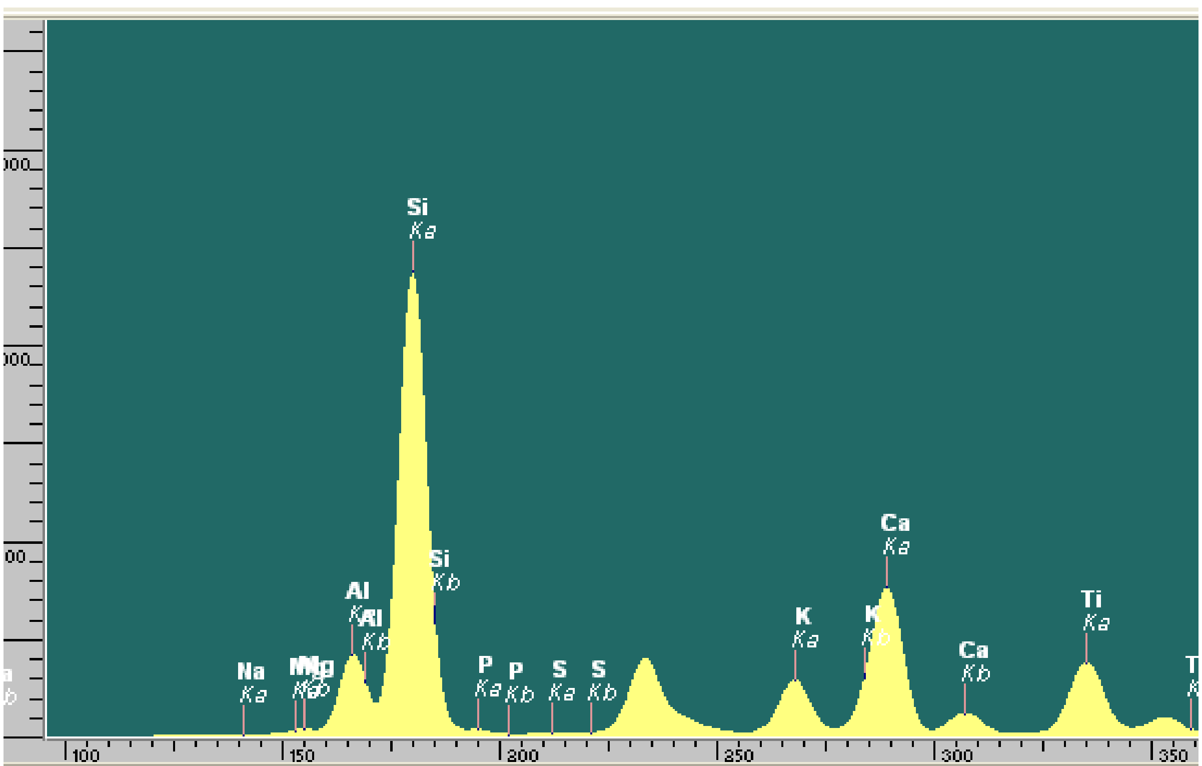


Fig (1.5) Spectrum of First part of Sample A 3
Location Lines :N 15^{o} 37\ 58.31\\ E 32^{o} 29\ 57.88

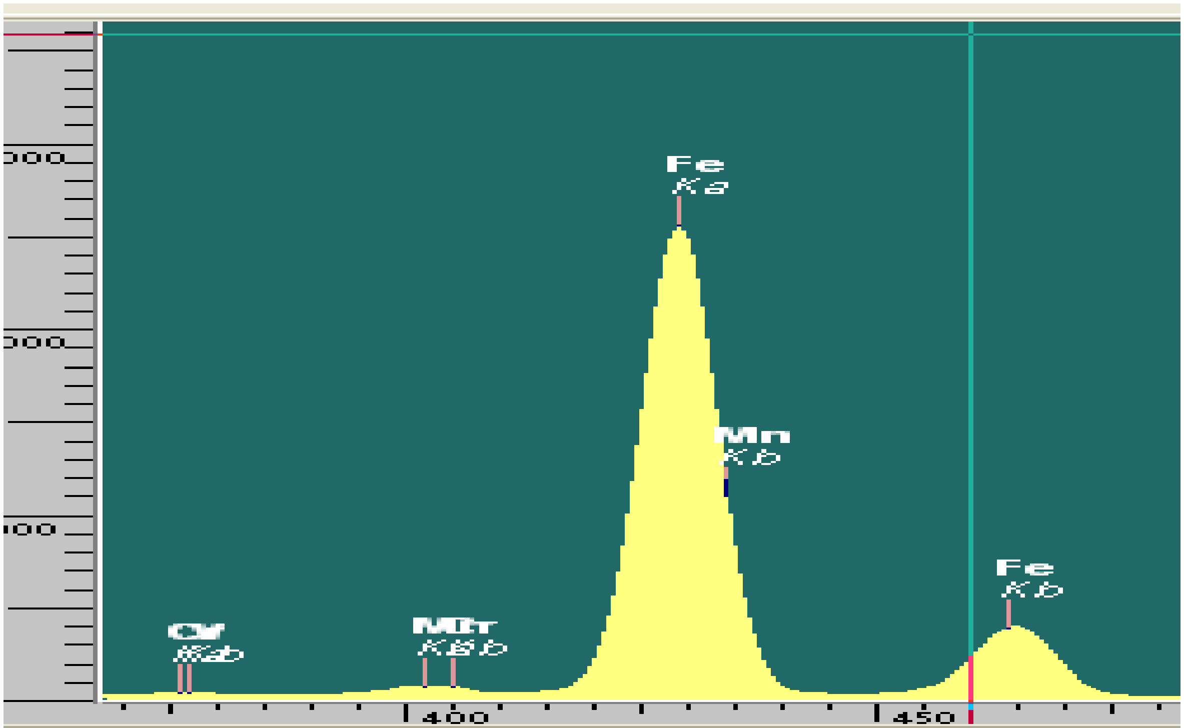


Fig (1.6) Spectrum of Second part of Sample A 3
Location Lines : N 15° 37\ 58.31\\ E 32° 29\ 57.88

Results of Testing Under Air Condition

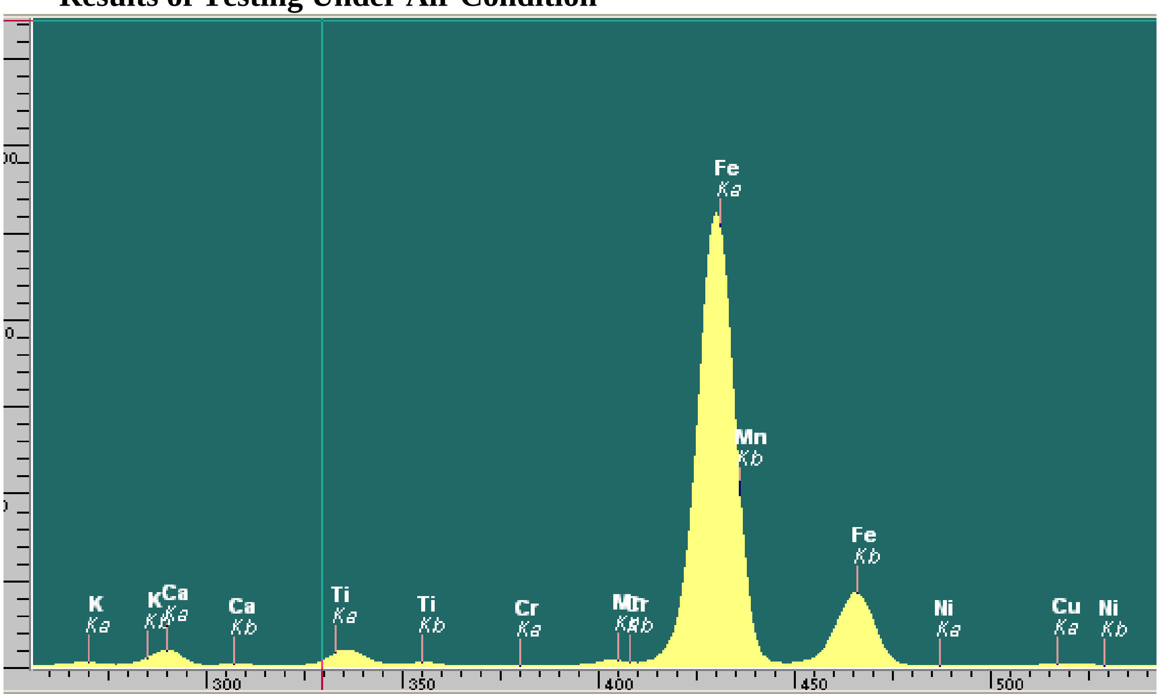


Fig (1.7) Spectrum of First part of Sample A 1
Location Lines: N 15° 37\ 57.79\\ E 32° 29\ 57.80

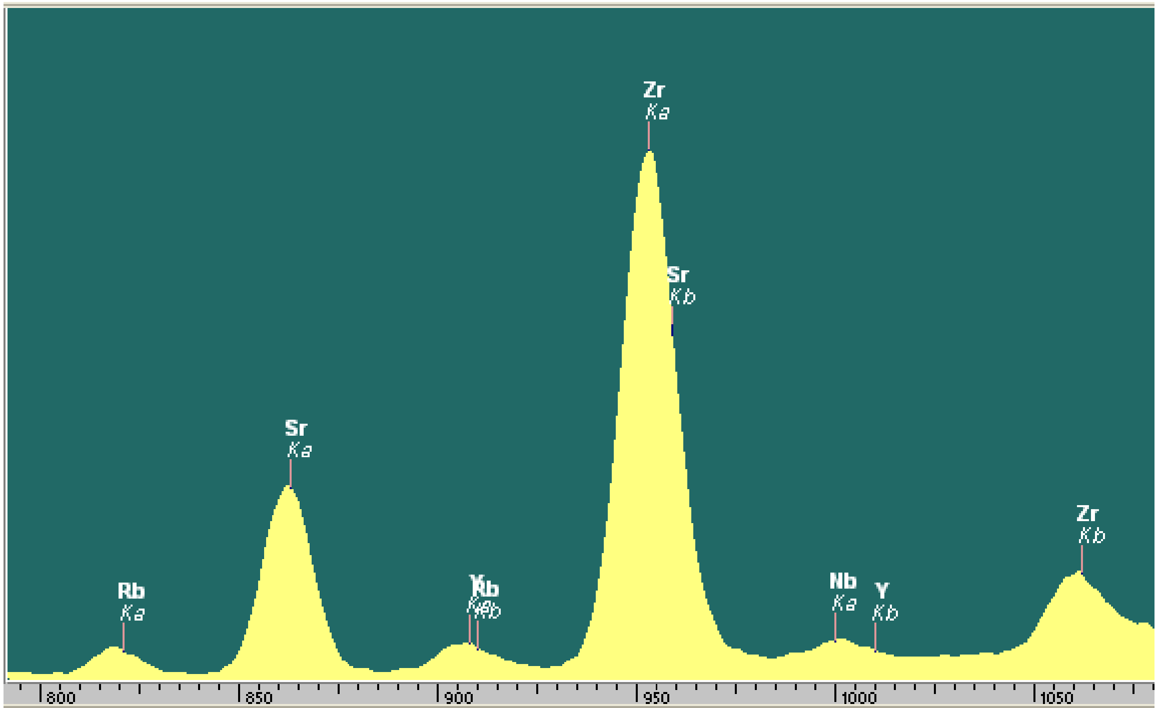


Fig (1.8) Spectrum of Second part of Sample A 1
Location Lines: N 15^{o} $37^{\backslash}$ $57.79^{\backslash\backslash}$ E 32^{o} $29^{\backslash}$ $57.80^{\backslash\backslash}$

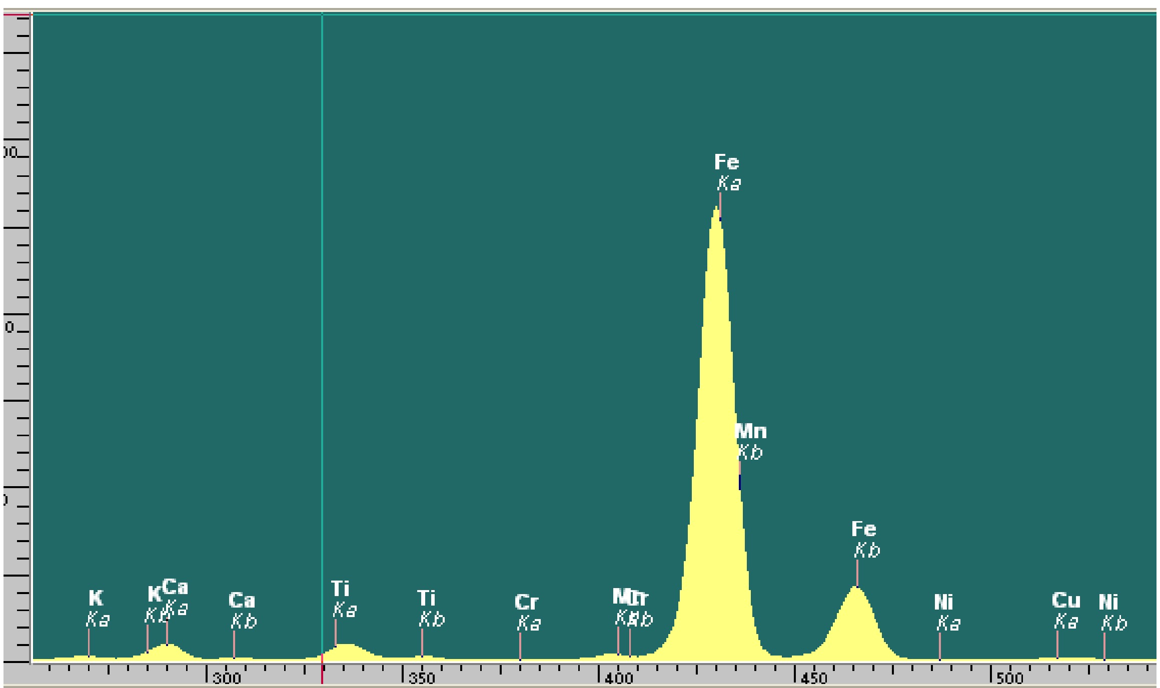


Fig (1.9) Spectrum of First part of Sample A 2
Location Lines: N 15^{o} $37^{\backslash}$ $57.96^{\backslash\backslash}$ E 32^{o} $29^{\backslash}$ $59.02^{\backslash\backslash}$

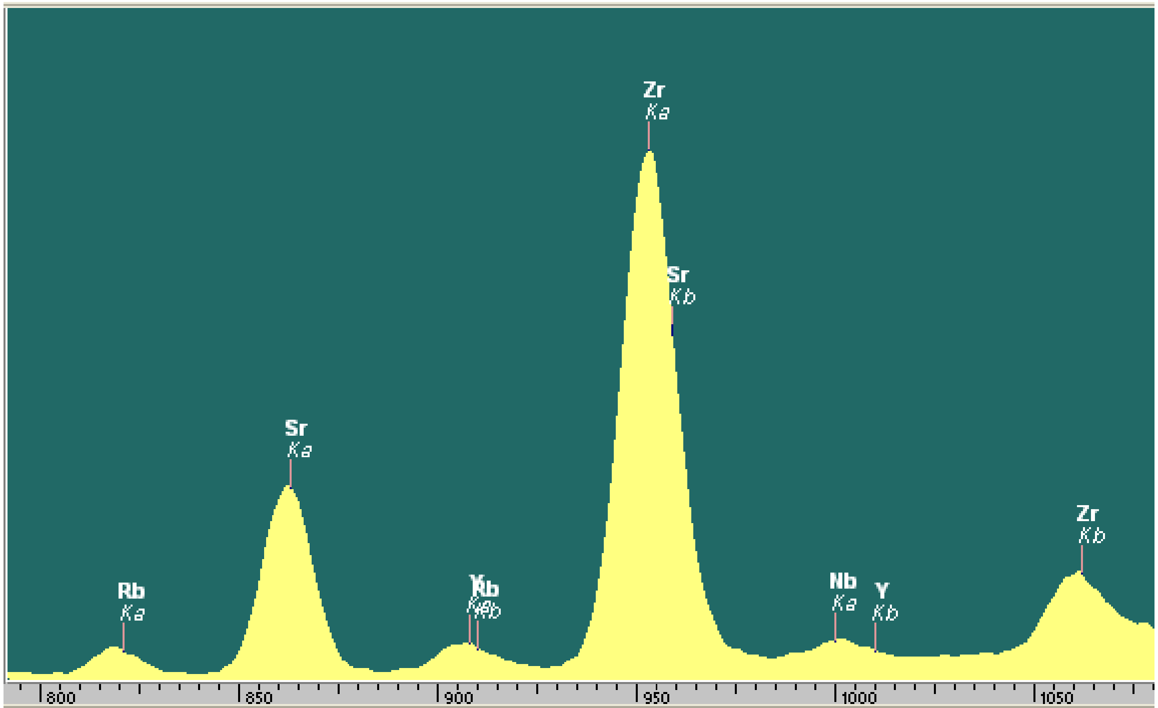


Fig (1.10) Spectrum of Second part of Sample A 2
Location Lines: N 15^{o} 37\ 57.96\\   E 32^{o} 29\ 59.02

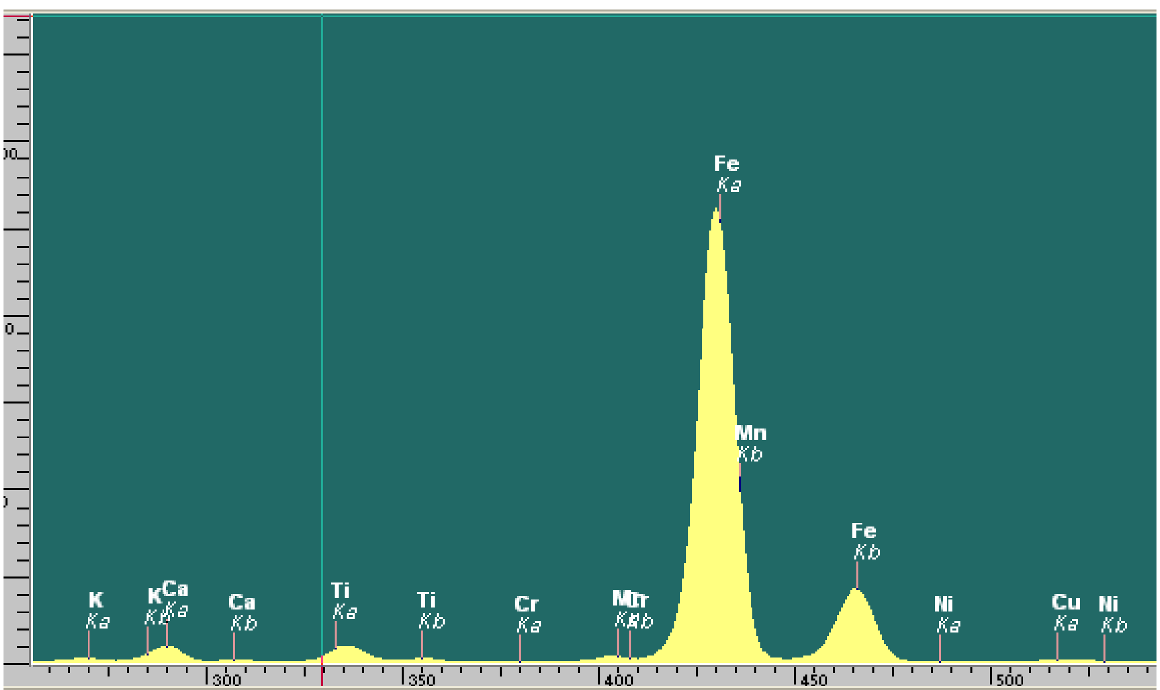


Fig (1.11) Spectrum of First part of Sample A 3
Location Lines: N 15^{o} 37\ 58.31\\   E 32^{o} 29\ 57.88

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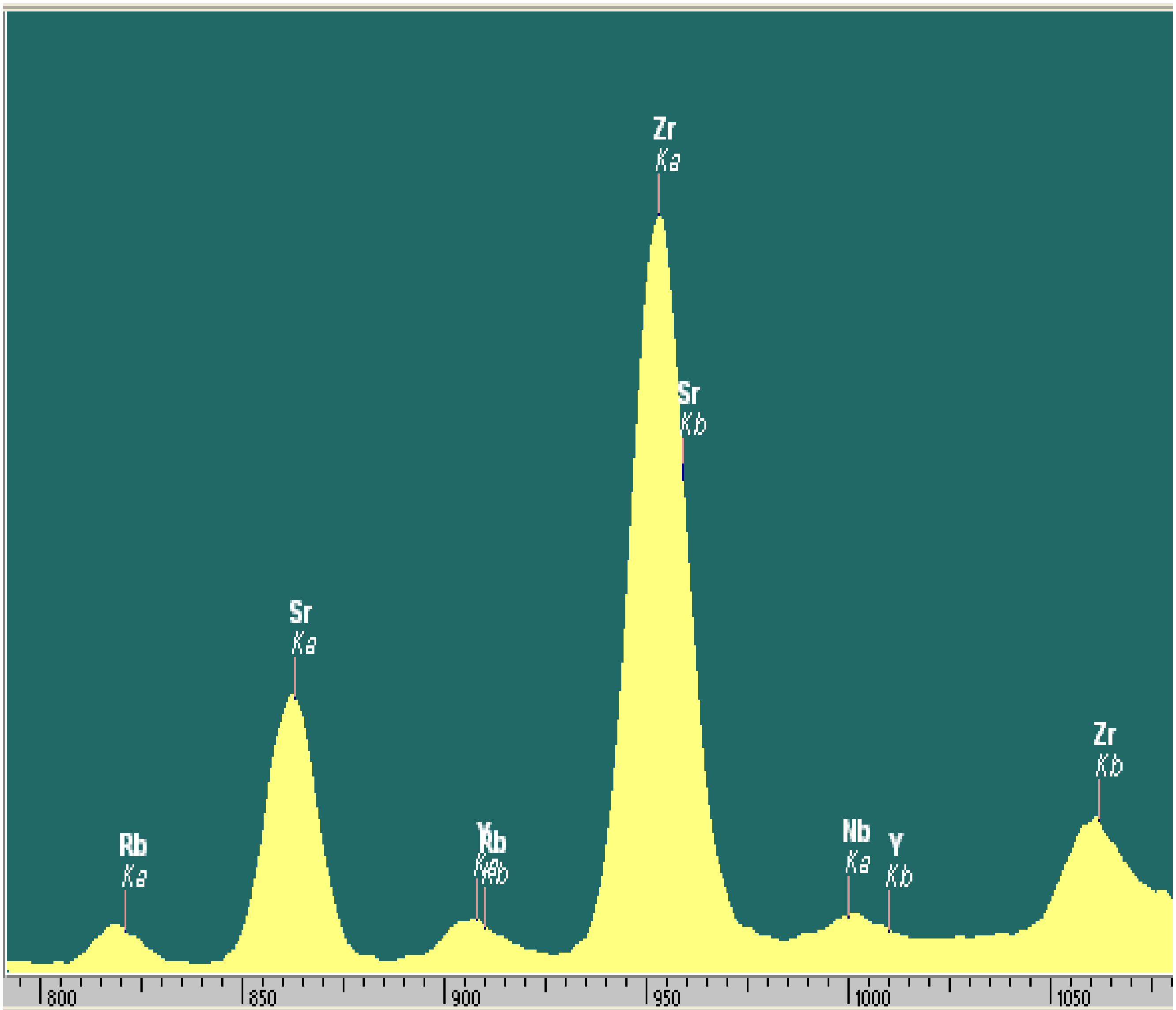

Fig (1.12) Spectrum of Second part of Sample A 3
Location Lines: N 15º 37\ 58.31\\ E 32º 29\ 57.88

1.Discussion

From the spectrum (which show the relation between the energy in the y axes and the channels of the analyzer in x axes) of the samples, we can get that:

Sample **A** contains elements Mg, Al, Si, K, Ca, Ti, Cr, Mn, Fe, Sr, Zr; and it may contain elements Na, P, S, Cu, Rb, Y, Nb;

2.Sardia Island Samples (B_1, B_2, B_3)

2.Results of Testing Under Vacuum Condition

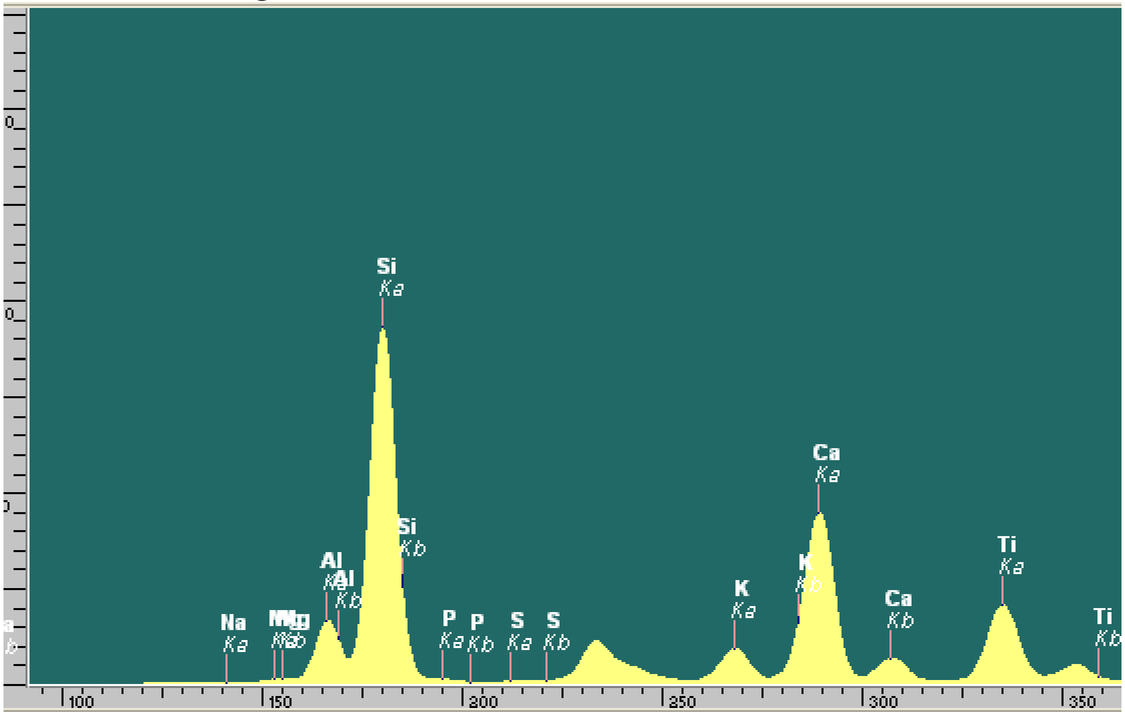

Fig (2.13) Spectrum of First part of Sample B 1
Location Lines: N 16^{o} 44\ 03.08\\ E 33^{o} 28\ 40.21

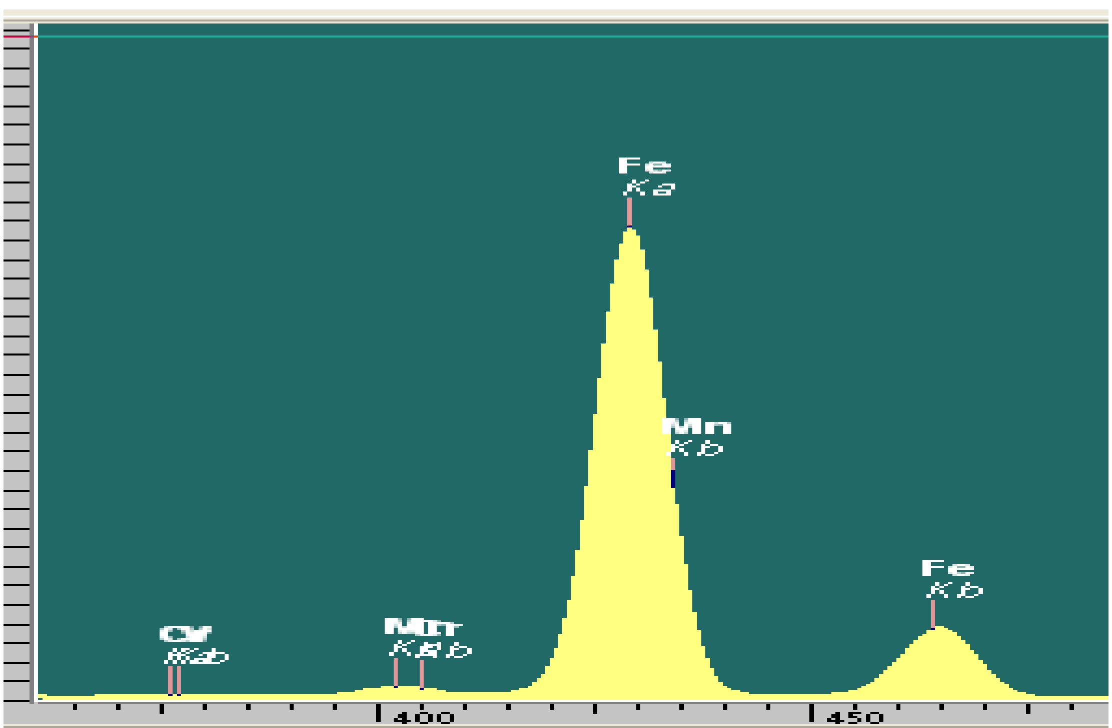

Fig (2.14) Spectrum of Second part of Sample B 1
Location Lines: N 16^{o} 44\ 03.08\\ E 33^{o} 28\ 40.21

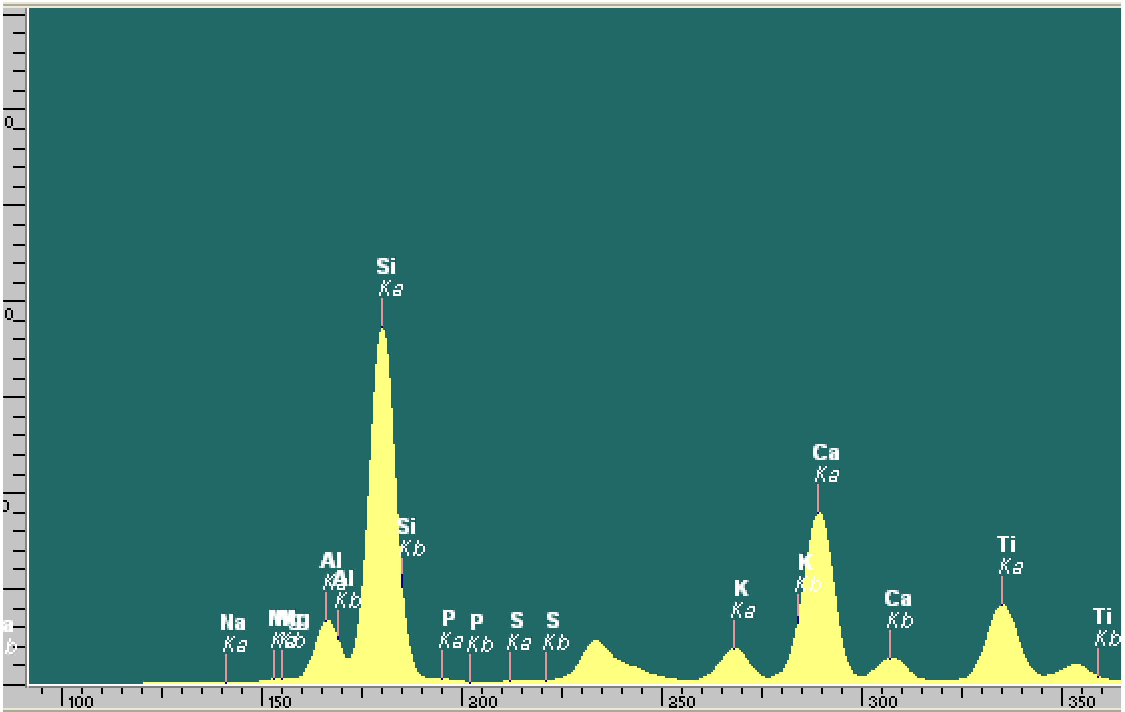

Fig (2.15) Spectrum of First part of Sample B 2
Location Lines: N 16° 44\ 03.72\\   E 33° 28\ 42.13

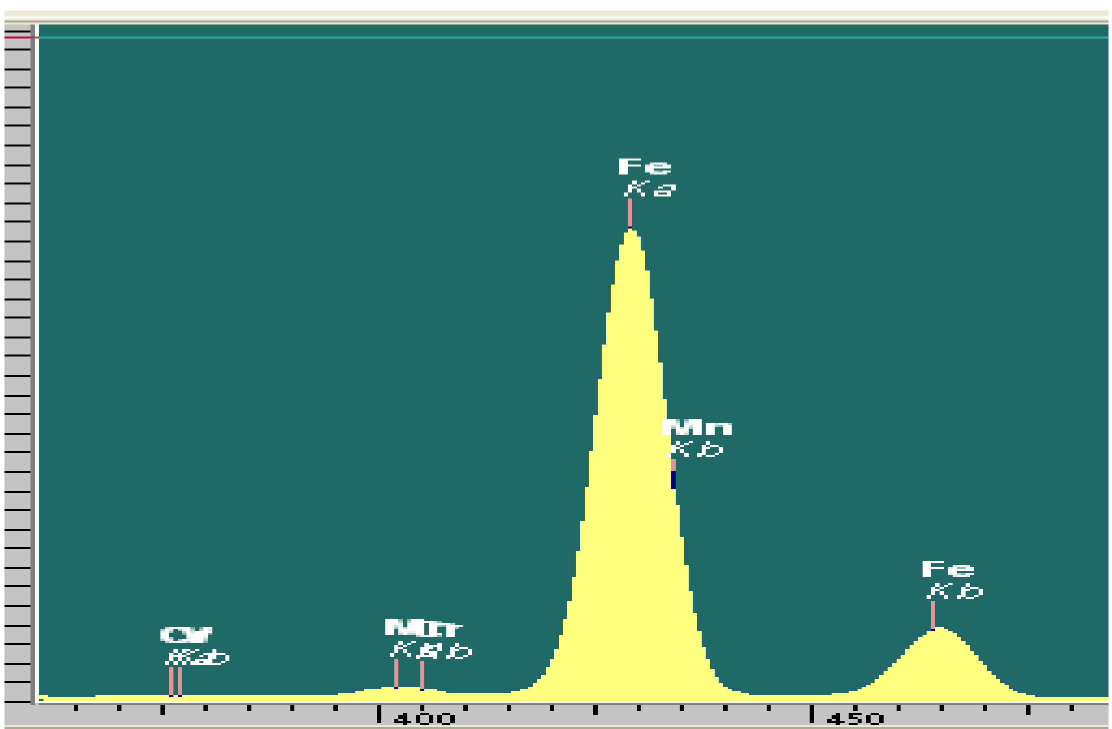

Fig (2.16) Spectrum of Second part of Sample B 2
Location Lines: N 16° 44\ 03.72\\   E 33° 28\ 42.13

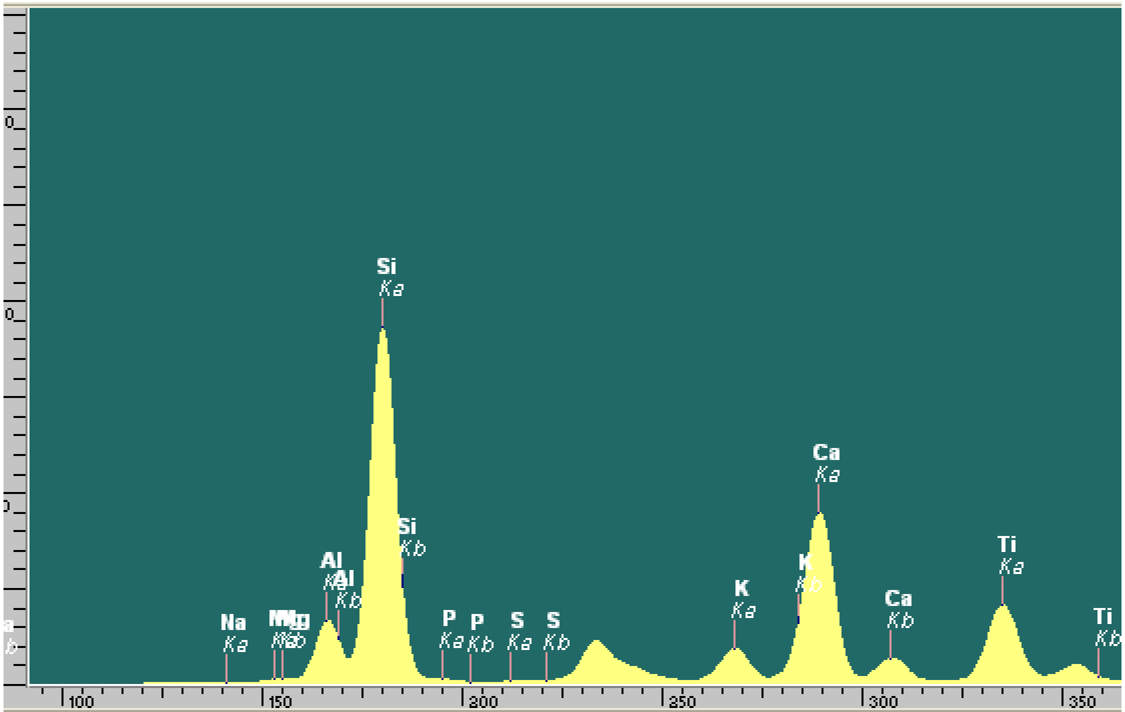

Fig (2.17) Spectrum of First part of Sample B 3
Location Lines: N 16° 44\ 04.43\\ E 33° 28\ 40.56

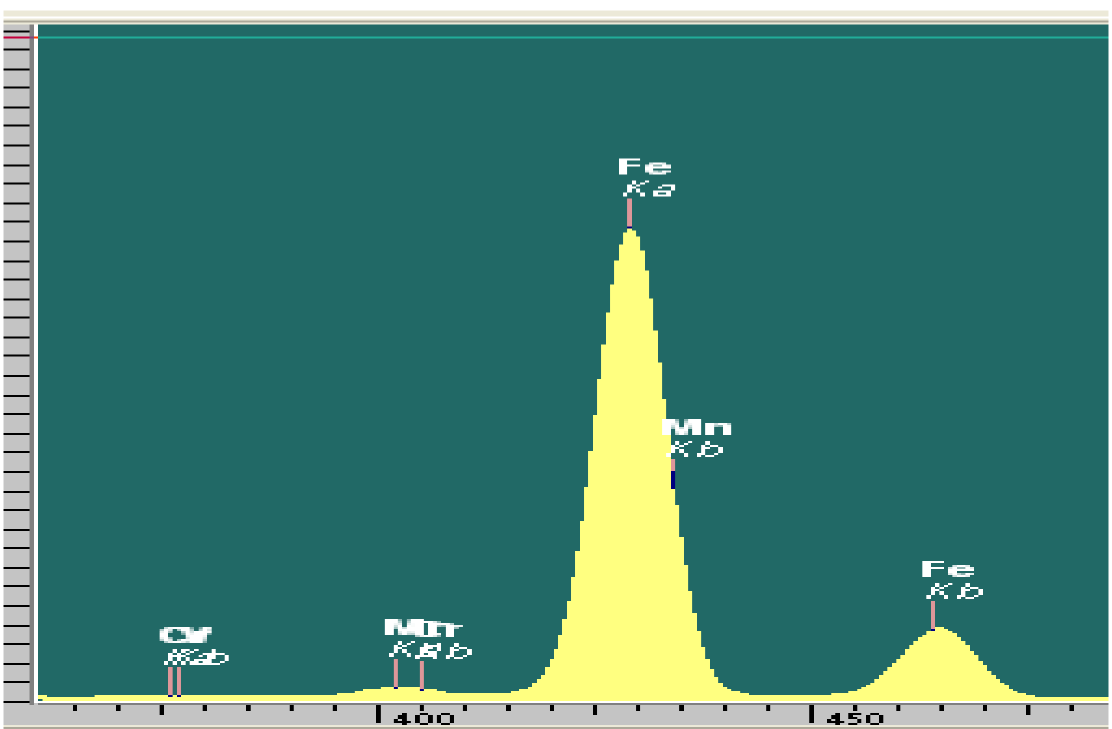

Fig (4.18) Spectrum of Second part of Sample B 3
Location Lines: N 16° 44\ 04.43\\ E 33° 28\ 40.56

2.Results of Testing Under Air Condition

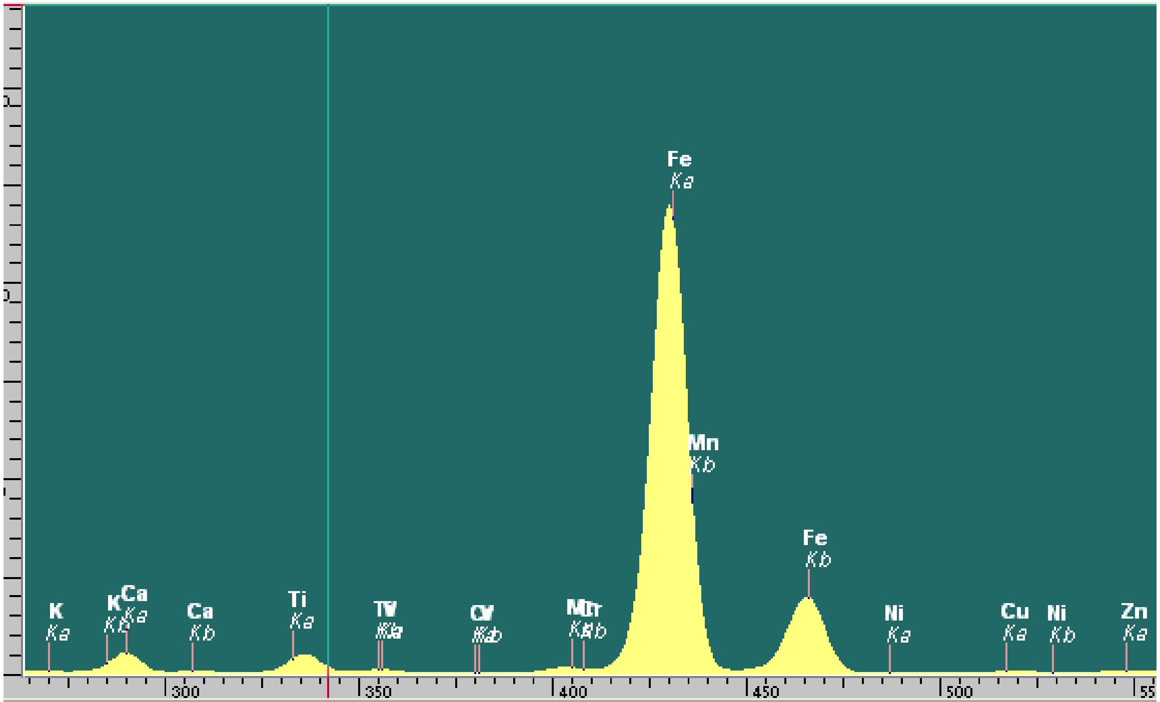

Fig (2.19) Spectrum of First part of Sample B 1
Location Lines: N 16^{o} 44\ 03.08\\ E 33^{o} 28\ 40.21

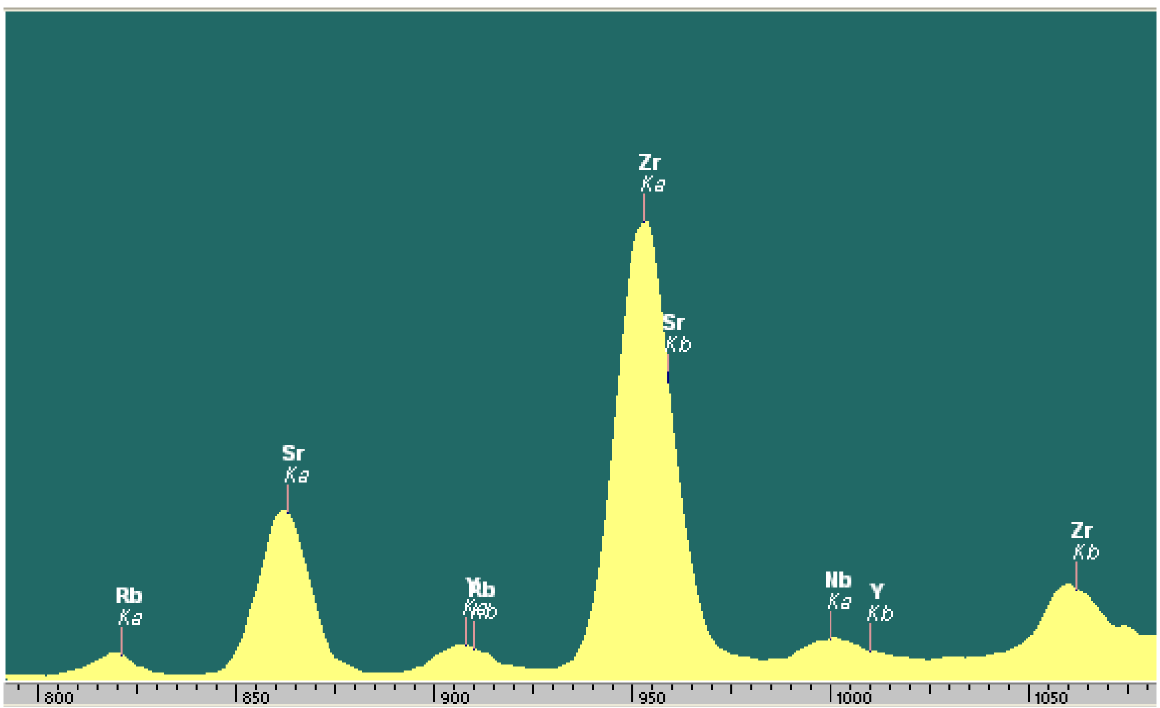

Fig (2.20) Spectrum of Second part of Sample B 1
Location Lines: N 16^{o} 44\ 03.08\\ E 33^{o} 28\ 40.21

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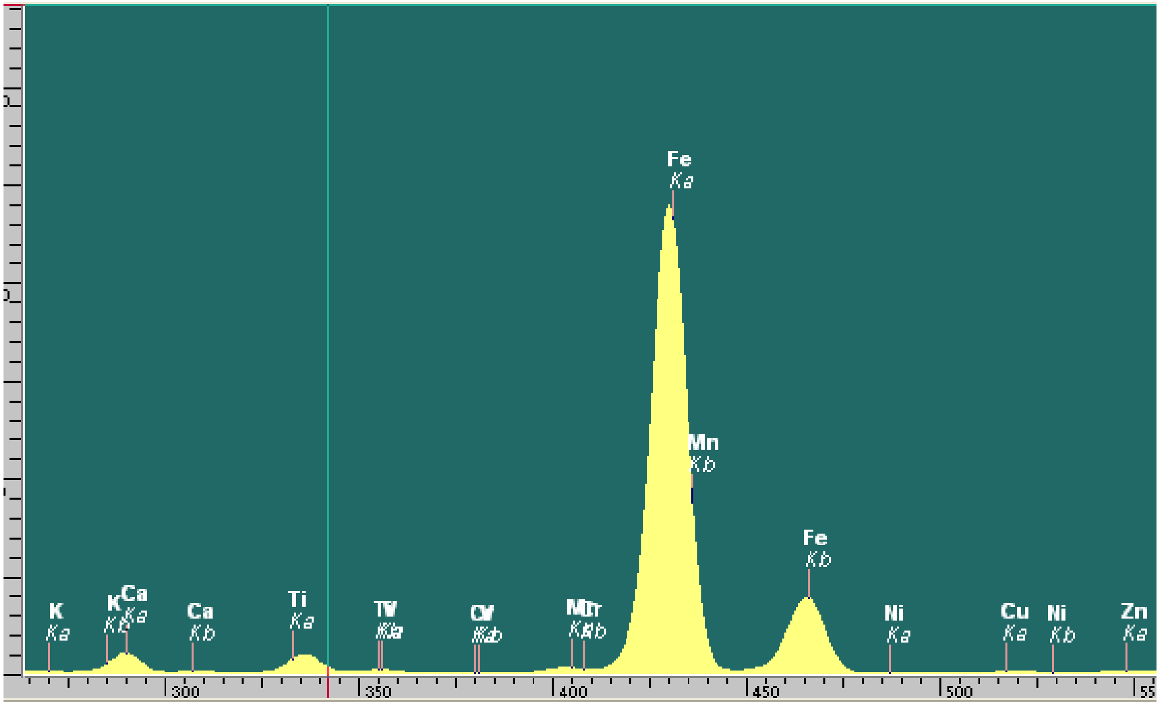

Fig (2.21) Spectrum of First part of Sample B 2
Location Lines: N 16^{o} $44^{\backslash}$ $03.72^{\backslash\backslash}$ E 33^{o} $28^{\backslash}$ $42.13^{\backslash\backslash}$

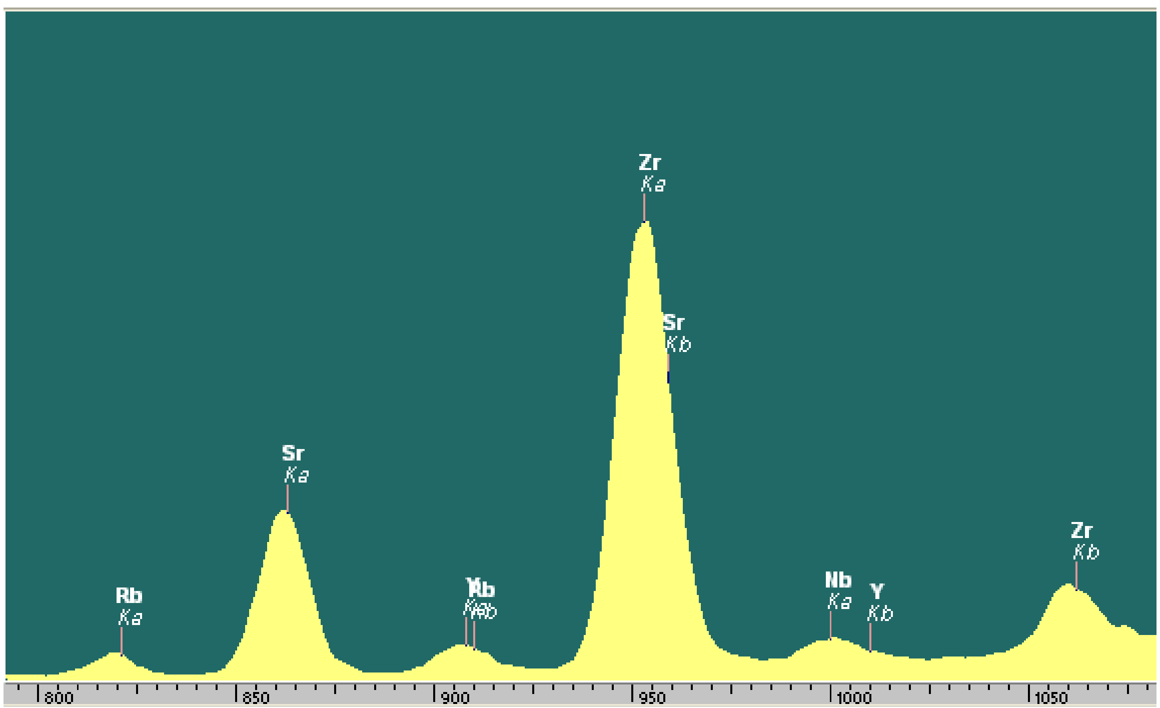

Fig (2.22) Spectrum of Second part of Sample B 2
Location Lines: N 16^{o} $44^{\backslash}$ $03.72^{\backslash\backslash}$ E 33^{o} $28^{\backslash}$ $42.13^{\backslash\backslash}$

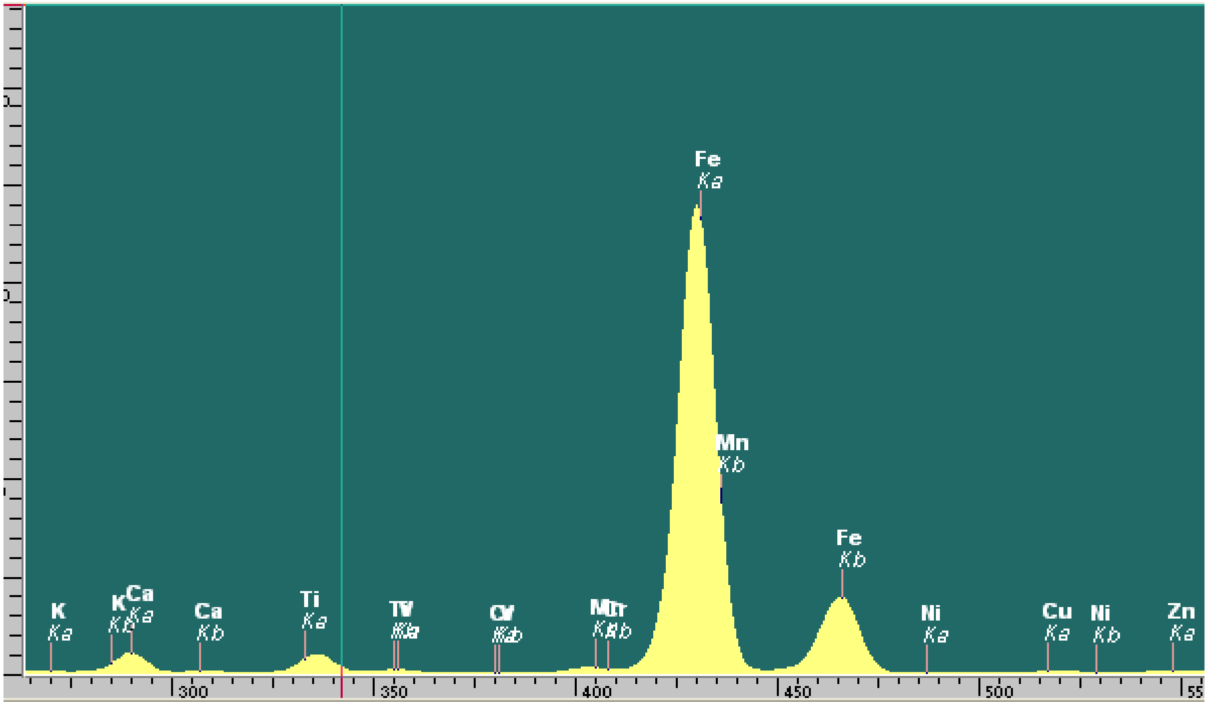

Fig (2.23) Spectrum of First part of Sample B 3
Location Lines: N 16^{o} 44\ 04.43\\   E 33^{o} 28\ 40.56

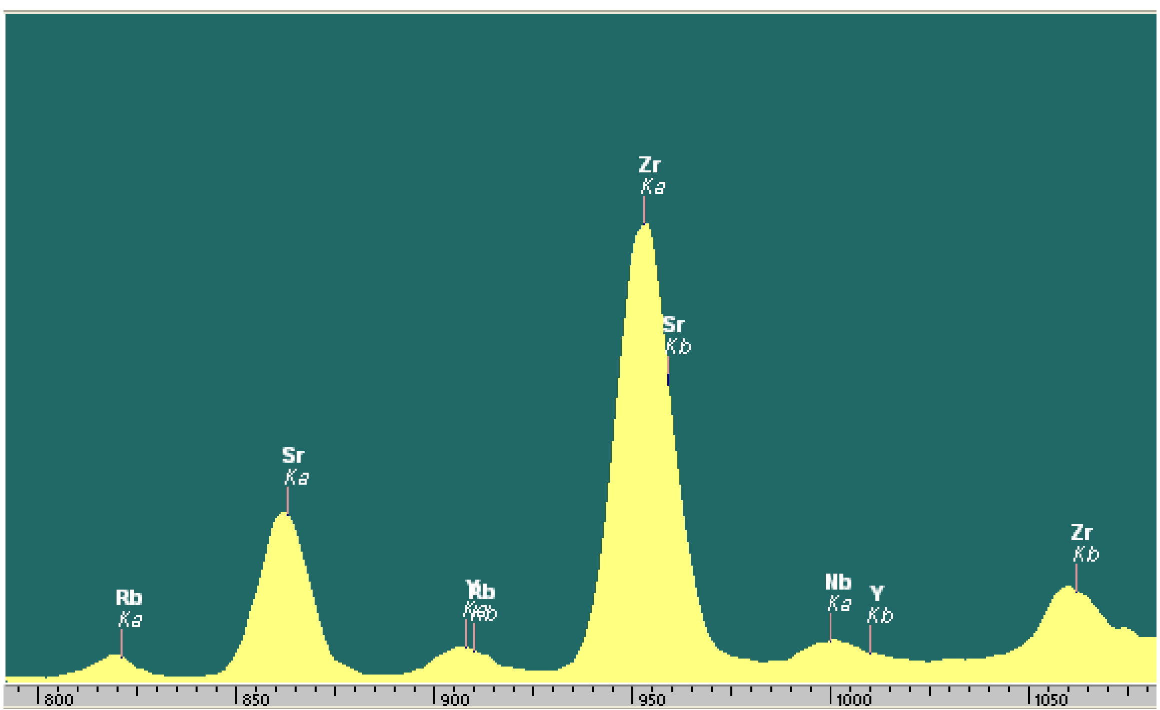

Fig (2.23) Spectrum of Second part of Sample B 3
Location Lines: N 16^{o} 44\ 04.43\\   E 33^{o} 28\ 40.56

2.Discussion

From the spectrum (which show the relation between the energy in the y axes and the channels of the analyzer in x axes) of the samples, we can get that

Sample **B** contains elements Mg, Al, Si, K, Ca, Ti, Cr, Mn, Fe, Sr, Zr; and it may contain elements Na, P, S, Ni, Cu, Rb, Y, Nb.

Conclusion

The results obtained show the present of the elements Mg, Al, Si, K, Ca, Ti, Cr, Mn, Fe, Sr, Zr, Na, P, S, Ni, Cu, Rb, Y and Nb in the samples tested, and the agricultural areas generally contain of the elements P, K , Ca , Mg , S, Fe, Mn, B, Cu, Mo, Zn ,Na ,Cl ,I ,Si ,F ,Co ,Cr ,Ni ,Ti and Y . So, the result shows that this sample are lacking of elements Zn, Cl, I, F and Co. And has more elements like Al, Sr, Zr Rb, and Nb.

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