



Sudan University of Science and Technology
College of Graduate Studies

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

**تحديد العناصر الأساسية في تربة
(توتي, ساردية) باستخدام فلورة الأشعة
السينية**

Partial Fulfillment of the Requirements of the Master Degree in
nuclear Physics

By:

Nafisa Badr Eldin Mohamed Salih

Supervised By:

Dr. Ibrahim Mohamed Elfaki

Jun 2008

بسم الله الرحمن الرحيم

قال تعالى:

﴿وقل ربي زدني علماً﴾

﴿ صدق الله العظيم ﴾

Dedication

To my families.....,
Who gave me self confident, knowledge, education
and happiness.
To my parents with love.

To those.....,
Who guided, supported, encouraged, taught and
helped me to achieve this goal. To my university,
teachers and colleagues with gratitude.

To my self.....,
To be loyal, respectful.....!!!

I dedicate this work

Nafisa BadrEldin Mohamed
Jun 2008

Acknowledgement

Great appreciation is given to Dr. Ibrahim Mohamed Elfaki my supervisor for the theoretical guidance and moral support, he successfully guided and followed the project.

The researcher is grateful to the staff at Skyray Instrument International company in China for their great assistance that they offered which made the completion of this project possible.

Finally I'm indebted to every one who provided comments, criticism and praise throughout the stages of the project.

Abstract

Soil analysis was done by 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. In samples A1, A2, A3 which are collected from Khartoum (Toty island) and B1, B2, B3 from Shandy (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.

This research had taken about all issues concerning the electromagnetic radiation, atomic and molecular spectrum, types of spectroscopy, x-rays fluorescent work technology, element analysis by using XRF technique, essential elements in soil and its values.

The results show that Sample A Type 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 Type 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.

Table of Contents

Contents	Page No
Dedication	I
Acknowledgement	II
Abstract	III
Chapter one Basic Concepts	
1.1 Electromagnetic radiation	1
1.1.1 (E M) Properties	1
1.1.2 Speed of electromagnetic radiation	2
1.1.3 Maxwell's equations	2
1.1.4 Table of electromagnetic spectrum	6
1.2 Atomic and molecule Spectrum	8
1.2.1 Atomic Spectrum	8
1.2.2 molecule Spectrum	10
1.3 Spectroscopy	12
1.3.1 Types of spectroscopic methods	12
1.3.2 Measurement process	13
1.3.3 Common types of spectroscopy	13
1.3.3.1 Fluorescence spectroscopy	13
1.3.3.2 X-ray spectroscopy and X-ray crystallography	14
1.3.3.3 Other types of spectroscopy	14
1.4 Essential element in soil and Plant Nutrition	15
1.4.1 Macro elements	15
1.4.2 Micro elements	16
1.4.3 Balance soil	17
1.4.4 Principle of Proportion	20
1.5 The Soil Ecosystem	20
1.5.1 Soil biology	21
1.5.2 Cation-Exchange Capacity (CEC)	21
1.5.3 Elements Cycles	21
1.5.4 Micronutrients	22
Chapter tow X-Ray Florescence	
2.1 X-Rays	23
2.1.1 X-Rays production	23
2.1.2 Bremsstrahlung X-Rays	25
2.2 XRF work technology	26
2.2.1 X-Ray florescence	26

2.2.2 X-Ray Scans	27
2.2.3 Sample Spot Analysis and 3-D Element Mapping by using W D S	27
2.2.4 Sample Analysis by Energy Dispersive X-Ray Fluorescence	28
(EDXRF)	
2.2.5 XRF Excitation Mode	28
2.2.6 light Element Analysis	29
2.2.7 Elemental analysis using the XRF technique	29
2.2.8 XRF applications	33
2.2.9 The physics of XRF	33
2.2.10 Energy dispersive spectrometry	37
2.2.11 Wavelength dispersive spectrometry	39
2.2.12. Extracting analytical results	40
Chapter three Experimental Work	
3 3.1 The Instrument used	42
3 3.1.1 Technical Specification	43
3 .1.2 Configurations	44
3.1.3 Performance	45
3.2 Testing Report	45
3.2.1 The Samples	45
3.2.2 Testing Requirement	45
3.2.3 Testing Condition	45
3.2.4 Testing Methods	46
3.2.5 Sample Preparation	46
3.2.6 Test procedure	46
Chapter four Results and Discussion	
4.1 Toty Island Samples (A_1 , A_2 , A_3)	47
4.1.1 Results of Testing under vacuum condition	47
4.1.2 Results of Testing under air condition	50
4.1.3 Discussion	53
4.2 Sardia Island Samples (B_1 , B_2 , B_3)	54
4.2.1 Results of Testing under vacuum condition	54
4.2.2 Results of Testing under air condition	57
4.2.3 Discussion	60
4.3 Conclusion	60
4.4 Future work	61
4.5 Remarks	61
Arabic Abstract	Iv
References	v

ملخص البحث

استخدم جهاز فلورة الأشعة السينية موديل (B3600) لتحديد العناصر المعدنية الأساسية في التربة "وذلك لدورها الحيوى فى جسم الإنسان, الحيوان والنبات" فى العينات A1,A2,A3 والتي أخذت من مدينة الخرطوم (جزيرة توتى) والعينات B1,B2,B3 والتي أخذت من مدينة شندي (جزيرة سارديه) والتربة التي أخذت منها العينات يذرع بها محصول الطماطم.

اجرى التحليل فى شركة (Skyscan) العالمية للأجهزة فى الصين تحت حالة الضغط الجوى العادى وتحت حالة التفريغ

تناول هذا البحث كل ما يتعلق بالأشعة الكهرومغناطيسية, الطيف الذري والجذئي, أنواع علوم الأطياف, تكنولوجيا عمل فلورة الأشعة السينية, استخدام تغنية فلورة الأشعة السينية فى الكشف عن العناصر المعدنية, أهمية العناصر المعدنية والتربة.

أظهرت النتائج ان العينات من النوع A تحتوي علي العناصر Mg, Al, Si, Na, P, K, Ca, Ti, Cr, Mn, Fe, Sr, Zr, S, Cu, Rb, Y, Nb

و العينات من النوع B تحتوي علي العناصر Mg, Al, Si, K, Ca, Ti, Cr, Na, P, S, Ni, Cu, Mn, Fe, Sr, Zr, Rb, Y, Nb.

