Ain Shams University
Faculty of Girls for Art,
Science & Education

STUDIES ON

APPLICATION OF GAMMA-RAY AND X-RAY FLUORESCENCE TECHNIQUES AND PHYSICAL SEPARATION METHODS ON STUDYING MONAZITE MINERAL

A THESIS
SUBMITTED IN PARTIAL
FULFILMENT OF THE REQUIRMENT FOR THE
MASTER DEGREE IN PHYSICS

BY
MAGDA MOHAMED IBRAHIM KHALIL

Supervising Committee

Prof. Dr. El-Beially, A.B.
Prof. of Physics
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Ass. Prof. Dr. Ashry, H.A.
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NCRRT., AEA

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Ass. Prof. of Geology
N.M.A.

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Date of Research : 9/4/1988

Approval Stamp:
Approval of Faculty Council

Date of Approval: / / 1993
Approval of University Council

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بسم الله الرحمن الرحيم

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Ain Shams University
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ACKNOWLEDGEMENT

It is a great pleasure, to express my deep indebtedness and sincere gratitude to :

1. Prof. Dr El-Beially, A. B., head of physics department, Faculty of Girls for Art, Science and Education, Ain Shams University
2. Ass. Prof. Dr. Ashry, H. A., Ass. Prof. of physics, National Center for Radiation Research and Technology (NCRRT)
3. Ass. Prof. Dr. Khazbzk, A. E., head of ore dressing department, Nuclear Materials (N.M.A.)

I would like to express my gratitude to :

1- Dr. Eng. Fouad A. S. Soliman, Ass. Prof., (NMA)
2- Prof. Dr. A. Z. El-Behay, head of Radiation Physics department (NCRRT)
3- Dr Dabour, G. M., Ass. Prof., (NMA)

Great thanks are also to :

1- Staff and members of the National Center for Radiation Research and Technology
2- Staff and members of the Nuclear Materials Authority

"In the name of **ALLAH** most merciful, most gracious" I Kneel humbly to **ALLAH** thanking **HIM** for showing me the right path. Without **HIS** help my efforts would have gone astray.

I would like to express gratefulness to **Prof. Dr. El-Beially, A.B.**, head of the physics department, Faculty of girls for Arts, Science, and Education, Ain-Shams University, who as sponsor of this thesis, has provided encouragement, help and advise towards the completion of this work.

I wish to express My special thanks to **Dr. Ashry, H.A. Ass. prof.** of physics National Center for Radiation Research and Technology (NCRT), Cairo, Egypt. for her direct suppervision, guidance during the whole work, encouragement and fruitful discussion and who initiated and directed the present work.

I am indepted to **Dr. Khazback, A.E. Ass. prof.** head of Ore Dressing department, Nuclear Materials Authority, Cairo, Egypt. for planing, his supervising the dressing experiments, guidance, help, valuable discussions and stimulation for this work.

The author wishes to express his grateful to **Dr. Eng. Fouad A.S. Soliman, Ass. prof.**, (NMA), for his active support, interest, helpful enlightening discussions, valuable advices and guidance during the different stages of this work.

My deepest thanks are due to **prof. Dr. A.Z. El-Behay**, head of radiation physics department (NCRRT), for his appreciated support and encouragement.

Best thanks are extended to **Dr. Dabour, G.M. Ass. prof.** and appreciate his kind help during the experimental work.

Thanks are due to to staff and members of the National Center for radiation Research and Technology and Nuclear Material Authority.

Also, I would like to acknowledge her Family, husband for the supplications and prayers. Finally thanks are also to those who helped me either directly or indirectly to finish this work.

ABSTRACT

The monazite is strategic and economic mineral which is suitable for profitable industrial exploitation as this furnish many raw materials for atomic energy and other aspects of our growing and expanding metallurgical and engineering industries.

For obtaining concentrated monazite, Physical separation methods depending on the physical properties of minerals are used to eliminate the great light minerals. These methods are gravitative, magnetic and electrostatic separation.

The aim of this work is to select an accurate, easy and rapid analytical technique, by which the control and adjustment of monazite and other natural ore samples during dressing practice can be successfully achieved.

In this study, three techniques have been carried out to determine monazite content at different stages of up-grading. These techniques are sized-grain counting, gamma-ray spectrometric and X-ray fluorescence spectrophotometry techniques.

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CHAPTER 1

INTRODUCTION

GENERAL INTRODUCTION AND OUTLINE OF WORK.

The black sands concentrates are composed mainly of ilmenite, magnetite, zircon, rutile, garnet and monazite. Great reserves of these minerals in the Egyptian beach deposits which are unique in their quantities and tenors of valuable economic and strategic minerals.

The monazite can be considered as a major source for thoria and urania in Egypt. To start with, the beach sands, contain an average of 10 % heavy minerals ranging between 5 and 60 percent over the beach littoral deposits north of Delta, this will necessitate the elimination of the great percentage of the light minerals admixed with the heavy ones. It is well established in the technology of beach sand treatment to start with the gravitative separation to bulk concentrate the heavy minerals. This will be followed by magnetic separation for separating the magnetic impurity minerals from the non magnetic monazite. Electrostatic separation was finally used for obtaining the magnetic concentrate having the suitable purity reasonable to be used for leaching for the production of U and Th.

Monazite is essentially an anhydrous orthophosphate of the cerium and the lanthanum group of the rare earth elements represented by cerium, lanthanum, praesodymium and neodmium.

Various methods have been and are still used in monazite analysis such as chemical analysis. This method is slow and needs a skillful ore analyst. It involve the assaying of thoria, rare-earths, phosphate and a correction for the uranium, calcium and silicon present in monazite.

The aim of the present study is to select an accurate, easy and rapid analytical technique, by which the control and adjustment of monazite distribution during the dressing practice can be successfully achieved.

In this study three techniques have been carried out to determine the concentration of monazite content at different stages of upgrading. To check the validity of these techniques, triplicate representative unknown samples were prepared from each stage of upgrading monazite.

The first technique is the sized-grain counting by using stereo-microscope. During this study the sized-grain counting was carried out for the different products from each stage.

Several rocks and minerals like monazite contain small amounts of thorium and uranium, the tracing of these elements is of interest and can be used to control the efficiency of different stages of upgrading. The present work discusses the use of gamma ray spectroscopy and X-ray fluorescence spectrophotometry for determining the abundances of natural thorium and uranium in monazite mineral.

There are two long-lived isotopes in natural Th and U namely ^{232}Th and ^{238}U, with half-lives of 1.41 x 10^{10} Y and 4.51 x 10^{9} Y respectively. In natural material, these isotopes and their decay products are in radioactive equilibrium. In the Th-series, the radioactive isotopes suitable for γ-ray spectroscopy are ^{228}Ac (emitting the 1588 KeV) and ^{208}Tl (emitting the 585 and 2614 KeV γ-rays), in the U-series the ^{214}Bi-isotope is the most suitable (emitting the 610 KeV, 1760 KeV and 2200 KeV γ-rays).

In the present measurements of the γ-ray spectra obtained in the decay of the isotopes in the Th and U series, use has been mainly made of NaI scintillation detector for its high efficiency. The 2614 KeV γ-line from the decay of ^{208}Tl was used to determine the absolute Th abundance and 1764 KeV γ-line was used for the determination of the absolute U. Also the total activity of the samples was measured by the integral counts from ^{40}K, U, Th.

The third technique is the energy dispersive x-ray fluorescence [ED-XRF]. Quantitative analysis is based on the location of the spectral lines characteristic of the elements. The major components of monazite samples are: Ce, La, Nd, Th, Pr, Sm, Gd, y, U, P, Si and Ca. The interference free Th($L\alpha$), with energy of 12.808 KeV, and the U($L\alpha$) with energy 13.438 KeV,