ELEMENTAL ANALYSIS OF GEOLOGICAL SAMPLES BY GAMMA RAY SPECTROSCOPY

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Nabiha Farag Soliman

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ELEMENTAL ANALYSIS OF GEOLOGICAL SAMPLES BY

GAMMA RAY SPECTROSCOPY

Supervisons	Position
1. Professor Dr. M. Kenawy M. A. Kenawy	Head of the Physics Dept., University College for Art, Science & Education, Ain Shams University.
2. Professor Dr. A.M.Hassan	Prof. of Experimental Nucl. Physics. Reactor & Neutron Physics Dept., Nuclear Research Centre, Atomic Energy Authority,
3. Dr. N.B. Rofail N.B. Rofail	Assistant Prof. of Experimental Nuclear Physics Reactor & Neutron Physics Dept., Nuclear Research Centre, Atomic Energy Authority.
4. Dr. B. El Ezabi	Physics Department, Faculty of Women, Ain Shams University.

Approved

Head of the Physics Department

M. A. Kenawy

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SUMMARY

The problem of remotely analyzing the geological ores is investigated in a combined neutron experiments. Nuclear techniques are used as the basis for rapid identification of many naturally occuring elements in the ores. Design and construction of a simulated borehole sonde and an ore containment of nested aluminium tubes for bulk material investigation have been made. The borehole sonde is consisting of a Ge-radiation detector, a shadow shield, paraffin wax and a (Pu/Be) isotopic neutron source. These have to be assembled within an aluminium tube casing of 70 cm in length and 12 cm inner diameter. Careful precaution has been taken against fast neutron stray to the detector.

In this field the importance of neutron source is axiomatic and of primary interest of bulk material analysis is the determination of neutron flux spatial

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High resolution neutron capture gamma-ray spectroscopy were performed using Hp Ge, 4096 MCA, Professional-350 series computer system and their electronic accessories for measurements and analysis. Prompt gamma ray spectra were obtained for different ore thicknesses to evaluate the cross-over region (effective ore depth).

Results of net peak areas versus ore thickness for selected gamma-lines showed that the sonde is sensitive to gamma photons produced farther to about 8 cm thick of monazite ore layer. Qualitative analysis of monazite ore under investigation is done. Passive measurement of natural radioactivity of monazite ore is also studied.

Delayed gamma-rays from thermal induced nuclear reactions have been used to estimate the praseodymium, samarium and cerium contents in monazite ore sample. A weight of 10 to 20 mg of each sample in a powder form encapsulated in a polyethene container was used. Sensitivity curves using different standard concentration

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values of Pr, Ce and Sm were constructed. These quantitative analysis has been achieved by using Pneumatic Irradiation Rabbit System.

The datails of these investigation are included in five chapters which stand as contents of this thesis.

The first chapture is an introduction dealing with the importance of the techniques used in this work also a literature review and the aim of this present work are given.

Chapter two, gives a review of the theoretical principles and limitations related to the techniques used.

Chapter three, describes the experimental arrangements, details of the design and construction of the experimental set-up and procedure for data analysis. This chapter gives also a brief account on the electronic equipment set-up. Linearity, energy calibration and absolute gamma-ray efficiency of the system used are presented.

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Chapter four, presents the results obtained of the qualitative and quantitative analysis of monazite ore. Discussions of the experimental measurements and their interpretation are throughly considered.
Conclusions of paramount importance are given in chapter 5 .

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CHAPTER (1)

INTRODUCTION

1.1- General Remarks

1.2- Literature Review

1.2.a- Prompt Gamma-Ray Neutron Activation Analysis (PGNAA)

1.2.b- In Situ Neutron Activation Analysis

1.3- Aim Of The Present Work

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CHAPTER (1)

INTRODUCTION

1.1 GENERAL REMARKS

When a neutron of any energy is captured by a nuclei, a compound nucleus is formed. However, in general, the probability of capture increases as the neutron energy decreases, and is higher at the thermal energies. The excess energy of the compound nucleus is the binding energy of the neutron plus its kinetic energy and is relieved by the emission of gamma-rays immediately after capture. These prompt photons emission, which are emitted within 10^{-14} sec., are called prompt gamma rays[1]. The gamma emission often takes place through several intermediate steps or energy levels. The compound nucleus can emit a neutron with conservation of kinetic energy as in elastic scattering, or with the additional emission of gamma-rays as in inelastic scattering.

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The excitation energy of the compound nucleus is divided among several nucleons , and any emission of a nucleon is delayed until it obtains an energy, from collision with other nucleons, greater than its binding energy in the nucleus.

Many nuclides after emitting the gamma-rays due to neutron capture are radioactive, and on decay, emit other gamma-rays with half lives of seconds to years. These latter photon emissions are called decay or delayed gamma-rays and are generally at a much lower energy.

These two basic decay mechanisms of thermal neutron radiative capture have been successfully used in elemntal analysis. The first one is employed in measurement of the radiative capture gamma-rays emitted almost immediately after neutron capture. The other makes use of the decay gamma-rays at a later time.

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