USES OF THE PROMPT THERMAL NEUTRON CAPTURE GAMMA-RAY TECHNIQUE IN MULTI - ELEMENTAL ANALYSIS.

A THESIS:

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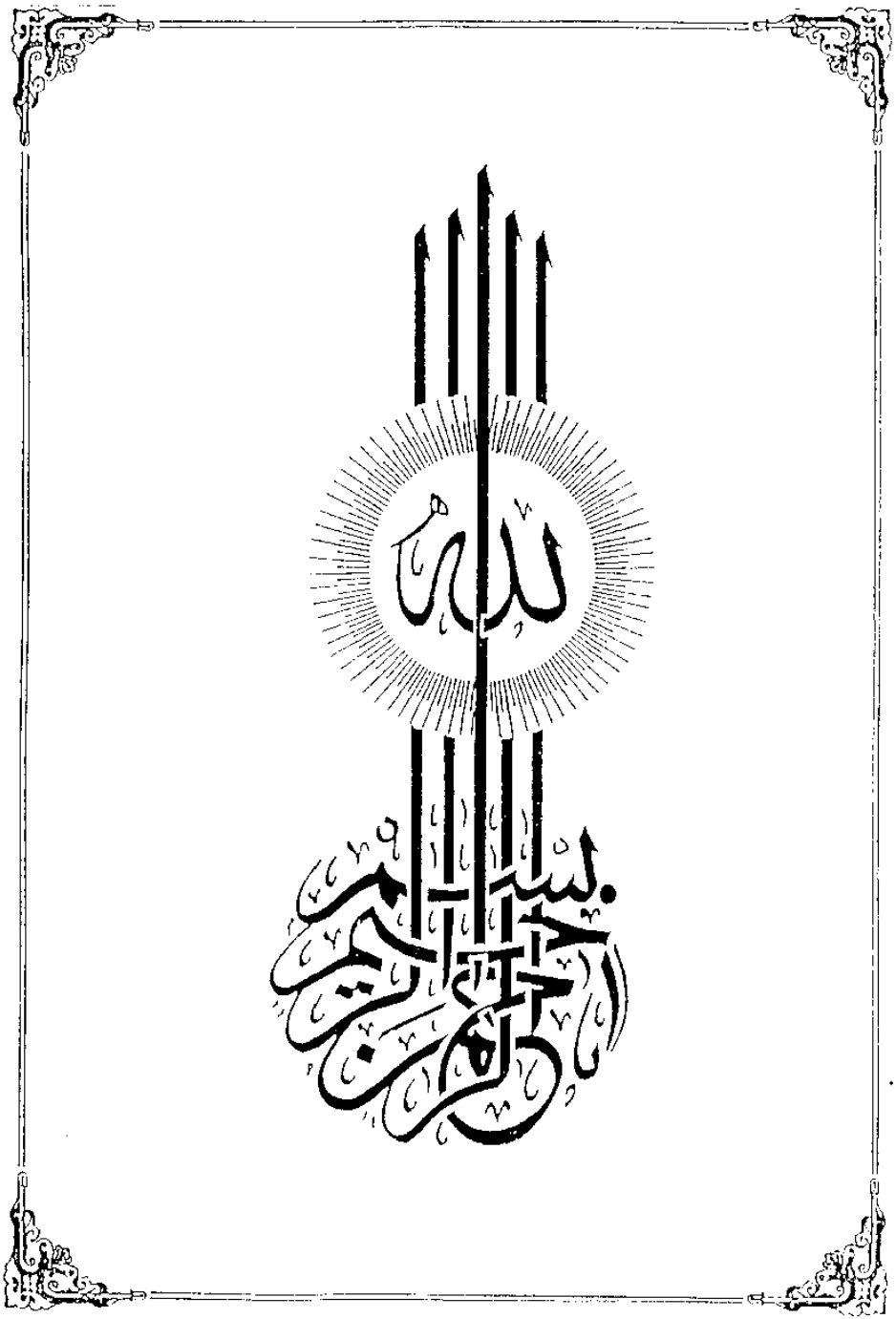

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SUMMARY

The prompt gamma - rays which immediately follow thermal neutron capture, as a sensitive and accurate tool, has heen used with success for elemental analiysis in diverse applications. the advantage of this method over other techniques are, rapid, usage of large samples size, high reliability and accuracy.

Over the past few years, several papers on prompt gamma-ray activation analysis have been published which demonstrate the potential of this technique by calculations or by analysis for one or two elements in the investigated samples. Few other reports are recently appeared on multielement applications to complex samples.

The incresing need for improved advanced techniques for nondestructive multielement analysis of complex samples has led to the devolopment in using the high yield isotopic neutrom sources with several neutron analysis techniques.

The (Pu/ Be) as an (α, n) source is considered as a reasonable high yield isotopic neutron source. It is cheap, easy to shield and highly portable and therefore, has considarable application for remote or field use, especially in field of the geological surveying.

In this work a system was designed to measure the prompt gamma-rays produced by the interaction of thermal neutrons emitted from the Pu / Be isotopic neutron source with ores and industrial samples. This system made it possible to study the feasibility of identifying the major and trace elements in bulk materials by the prompt gamma-ray technique.

A wooden box with volume of about 0.35 m^3 was used as a sample container. At the centre of this box, a neutron-detector shield tube containing the neutron source, the shadow shielding and the Ge(Li) detector-was positioned. The assembly was designed and constructed for high gamma-ray sensitivity and low interference and radiation damage

from the neutron source. A Ge(Li) detection system was used for gamma-ray measurements.

The well resolved and intense gamma-ray lines obtained from the neutron capture gamma-rays in NaCl sample were used for energy and efficiency calibration of this system. Complete spectra for gamma-ray energies between 450 keV and 9000 keV were measured.

A domestic limonite sample has been investigated, it was of sufficient size to permit total attenuation of neutrons from the 2.5 Ci Pu/Be isotopic neutron source. More than 160 gamma-ray lines have been observed in the limonite spectrum. The more prominent gamma-ray lines were used to identify the concantrations of Fe, Si, Mg, Ti, Al, Cl, Na, and Mn as major elements in this sample. The following elements, S, K, Ca, V, Cr, Ni, Zn, and Sn could be identified from the obtained promt gamma-ray spectra, as minor elements with small concentration.

For quantitative analysis, an empirical formula encluding the efficiency of the detection system and the reported values of the sensitivity index of elements was used.

The single and the double escape peaks appeared in the high energy region of the measured spectrum (3000-9000 keV). gives valuable information for both qualitative and quantitative analyses. The results were compared with conventional analysis carried out by different techniques.

The details of these studies mentioned above have been presented in four chapters which stands as the main content of this thesis.

In the first chapter, a review on the history, of the nuclear activation technique used and the role of the neutron capture gamma-ray spectroscopy in multielemental analysis. The aim of this work was mentioned.

In the second chapter, the principles and theoretical basis of the prompt radiation activation analysis and the

elemental concentration evaluation in complex samplex samples have been discussed.

Chapter threes of rhis thesis was dealing with the design and construction of the prompt gamma-ray system for elemental analysis of complex samples and the experimental set-up. In this chapter the details of design and calibration of this system using Nacl sample were presented.

In chapter four of this thesis, the results and discussion of the analysis of the domestic limonite sample using the dessribed prompt gamma-ray system were reported. The qualitative and quantitative analysis as well as the special problems associatei with the determination of the presence of the investigated elements were discussed. A comparitive studies with the results obtained for some elements with other techniques were also mentioned.

In conclusion of this thesis it was clear that the experimental results obtained using the neutron capture

gamma-ray activation technique, indicates that it is well suited for elemental analysis of complex samples and could be utilised in field,