# THE USE OF SOME EGYPTIAN CLAYS FOR THE PRODUCTION OF GLASS-CERAMIC MATERIALS

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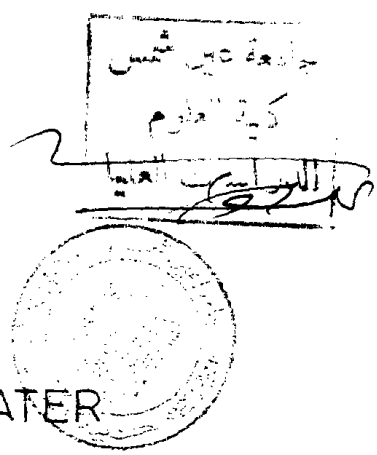
THESIS

SUBMITTED

TO

The Faculty of Science,

Ain Shams University



BY

GAMAL ABOUELGHEAT KHATER

( B. Sc. )

In Partial Fulfillment of the Requirements for the Degree

of

MASTER OF SCIENCE

In

GEOLOGY

NATIONAL RESEARCH CENTRE

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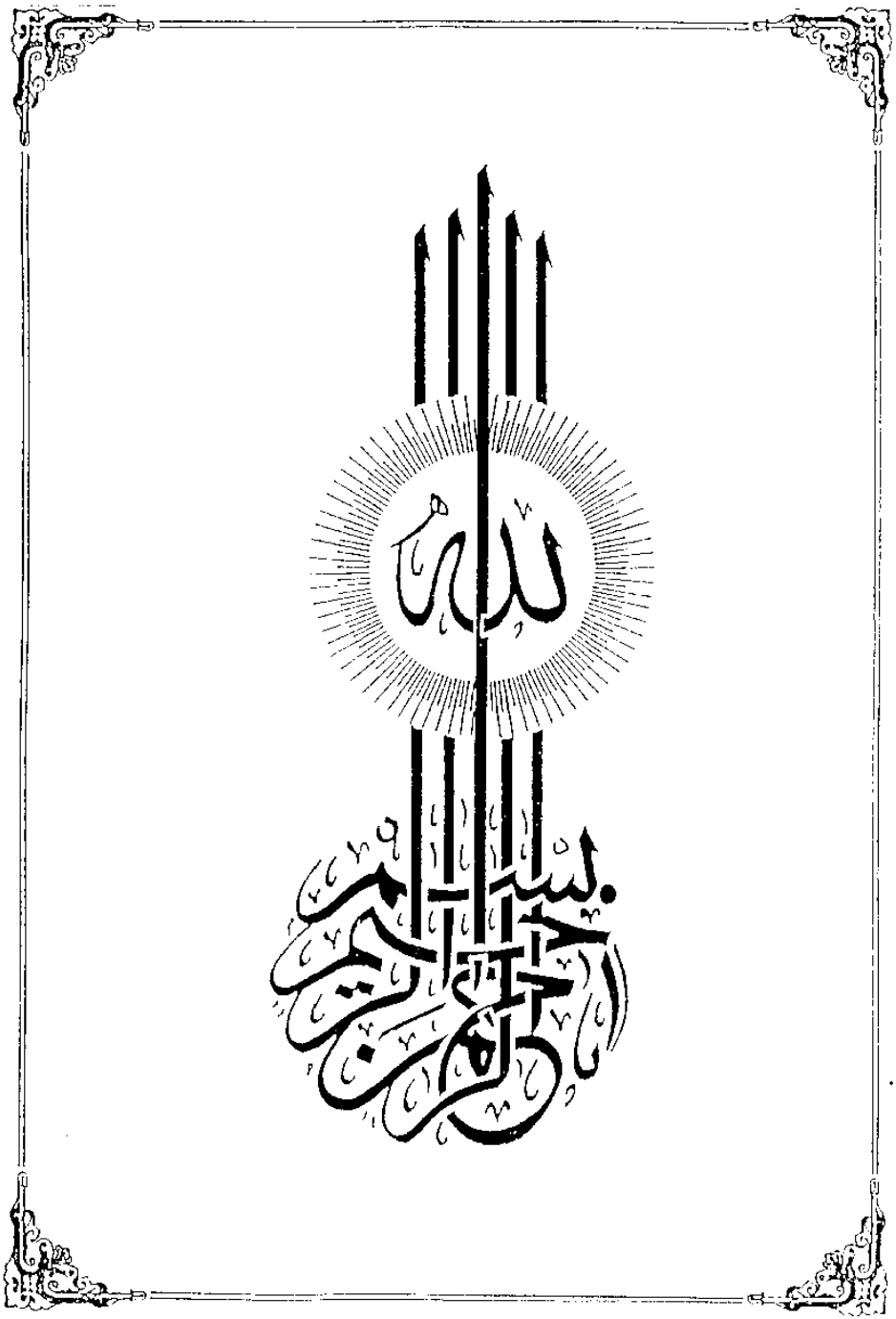


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THE USE OF SOME EGYPTIAN CLAYS FOR THE PRODUCTION OF GLASS-CERAMIC MATERIALS

Thesis Supervisors

Approved

Prof. Dr. M.E. HILMY .....

Prof. Dr. A.A. OMAR .....

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" N O T E "

The present thesis is submitted to Faculty of Science, Ain Shams University in partial fulfillment of the requirements for the M.Sc. Degree in Geology.

Besides the research work carried out in this thesis, the candidate has attended nine graduate courses for one year in the following subjects:

1. Cartography and geological mapping.
2. Geologic laboratory techniques.
3. Tectonic setting of Egypt.
4. Igneous rocks.
5. Sedimentary rocks.
6. Metamorphic rocks.
7. Mineralogy.
8. Geochemistry.
9. Crystallography.

He has passed successfully the final examination of these courses held in March, 1982.

Prof.Dr. M.A. BASIOUNI
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# C O N T E N T S



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# A B S T R A C T

This thesis deals with the appraisal of the suitability of some Egyptian clay rocks for use as a source of alumina and silica in the production of glass-ceramic materials. The use of natural rocks for the production of crystalline glass materials is a recent field of technology in Egypt. The batches were melted into glass. The obtained glasses were treated through different heat-treatment Schedules. Other similar batches were prepared with minor additives of $TiO_2$, $P_2O_5$ or $ZrO_2$ as nucleating agent.

The present work comprises the study of the mineralogical composition of the crystalline products as well as the textures formed in relation to the chemical composition of the original melt (glass) and the parameters of the crystallization process.

Five glass compositions of different calculated percentages of cordierite and spodumene ranging from 90% to 50% cordierite at 10% intervals were selected for the present study.

The main end products of crystallization under conditions approaching thermodynamic equilibrium were B-spodumene and cordierite.

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Sapphirine and or spinel may be formed instead of cordierite specially under non-equilibrium conditions of crystallization.

The effect of the type of crystallization catalyst on the melting of batches and crystallization process of the glasses obtained as well as on the mineralogical constitutions and textures formed in the resultant glass-ceramics was also studied.

The thermal expansion characteristics of the glasses and corresponding crystalline products were determined, and the data obtained were recorrelated with the type and quantity of the phase precipitated and the heat-treated glasses.

The results obtained in the present work may be of great help for the interpretation for the formation of the different types and assemblages of mineral phases and solid solutions which constitute the technological basis for the production of glass-ceramics.

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PART ONE

1. INTRODUCTION AND LITERATURE REVIEW.
2. RAW MATERIALS, BATCH PREPARATION AND COMPOSITIONS OF INVESTIGATED GLASSES.
3. EXPERIMENTAL TECHNIQUES.

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# CHAPTER ONE

# INTRODUCTION AND LITERATURE REVIEW

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# CHAPTER ONE
# INTRODUCTION AND LITERATURE REVIEW

## 1. General Considerations:

Crystalline-glass materials, or glass-ceramics, are new synthetic, generally, silicate products of very interesting peculiarities. They have good physical, chemical and mechanical properties. Consequently, they meet many valuable uses in the different domestic, medical, military fields and they show good promise for wider areas of application in the future (Beall, 1972).

Glass-ceramics can be produced by controlled crystallization of glasses of suitable chemical compositions. The process of crystallization can lead to the formation of very fine-grained uniform textures consisting of small randomly oriented crystals with residual interstitial glass cementing the crystals (Toropov, 1964; Stookey, 1959; Poria-Koshits, 1965; McMillan, 1979; and Berezhnoi, 1970).

The composition, nature and character of the crystalline phases formed in these glass-ceramic materials as well as the texture of the resultant products are the most important factors affecting the technical properties of such polycrystalline materials ( Hench, 1967).

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The fundamental chemical system for the production of crystalline-glass materials is usually chosen in the composition regions corresponding in the phase diagrams to the regions close to phase separation lines of the desired crystalline phases (Jones, 1971).

The use of raw materials such as sedimentary or igneous rocks for the production of glass-ceramic materials is of great economic technological and scientific importance. With proper correction of the chemical composition, the different types of sedimentary and igneous rocks can be successfully used for the production of crystalline-glass materials of different microstructures and mineralogical constitutions having many valuable technical properties. Furthermore the study of crystallization processes taking place in rock melts and their corresponding glasses has a great contribution to petrology.

## 2. Concepts of Glass-ceramics:

"Glass-ceramics" is a generic name given to materials which were first melted, formed into glass, and then crystallized in a controlled manner to yield non-porous polycrystalline products of unusual properties.

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