

# IGNEOUS NEPHELINE - BEARING ROCKS OF ÇUKURKÖY (NORTHERN PART OF PROVINCE OF KAYSERİ, TURKEY)

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## I. INTRODUCTION

During the summer of 1965 the geologist G. Pasquare investigated geologically the region of Çukurköy. This region lies at a distance of about 55 km NE of the large city of Kayseri in Eastern Turkey. This geological investigation showed an occurrence of igneous nepheline-bearing rocks in the vicinity of Çukurköy. Due to the scarceness of alkaline rocks in Turkey, it was thought desirable to make a detailed study of these rocks. Therefore these igneous rocks were petrographically investigated by A. Kraeff.

## II. GEOLOGY AND PETROGRAPHY OF THE REGION OF ÇUKURKÖY

(Figure 1)

This geologically investigated area lies south of Çukurköy along the At Deresi, a small tributary of the large river Kızılırmak.

Rock formations of this area can be subdivided, from old to young, into :

- A. Gneisses and marbles.
- B. Igneous complex of SiO<sub>2</sub>-saturated sodium-rich rocks and alkaline rocks.
- C. Neogene and alluvial deposits.

### A. Gneisses and marbles

The gneisses and marbles belong here to the oldest geological rock unit. This unit consists of the somewhat older formation of gneisses and the slightly younger formation of marbles.

The gneiss formation consists of biotite-gneisses, quartzites, quartzitic sandstones and of cataclastic quartzitic sandstones. The gneiss formation contains intercalations of marble in the upper part.

Marbles consist of coarse-grained calcite. Some marbles in the vicinity of their contact with the igneous alkaline rocks show small apophyses of nepheline-syenites.

Tectonically this gneiss-marble formation is striking in NE-SW direction and forms two anticlines separated by a syncline whose axes strike NE-SW. Their tectonic position is due to the later updoming of the-igneous rocks of At Deresi. The age of this gneiss-marble formation could not be determined, but it probably belongs to the Paleozoic.

**B. Igneous complex of SiO<sub>2</sub>-saturated sodium-rich rocks and alkaline rocks**

The igneous complex of SiO<sub>2</sub>-saturated sodium-rich rocks and alkaline rocks outcrops along the At Deresi. These igneous rocks are intruded into the older gneiss-marble formation and caused by their updoming the tectonic deformation of the gneiss-marble formation.

This igneous complex can be divided into :

1. SiO<sub>2</sub>-saturated sodium-rich igneous rocks.
2. Alkaline igneous rocks.

1- *SiO<sub>2</sub>-saturated sodium-rich igneous rocks.*— The SiO<sub>2</sub>-saturated sodium-rich igneous rocks outcrop in the NW part of this igneous complex, viz. in the vicinity of the small village of Hayriye. Among these SiO<sub>2</sub>-saturated sodium-rich rocks could be distinguished: sodaclase - syenodiorites, sodaclase - granodiorites, sodaclase-syenites.

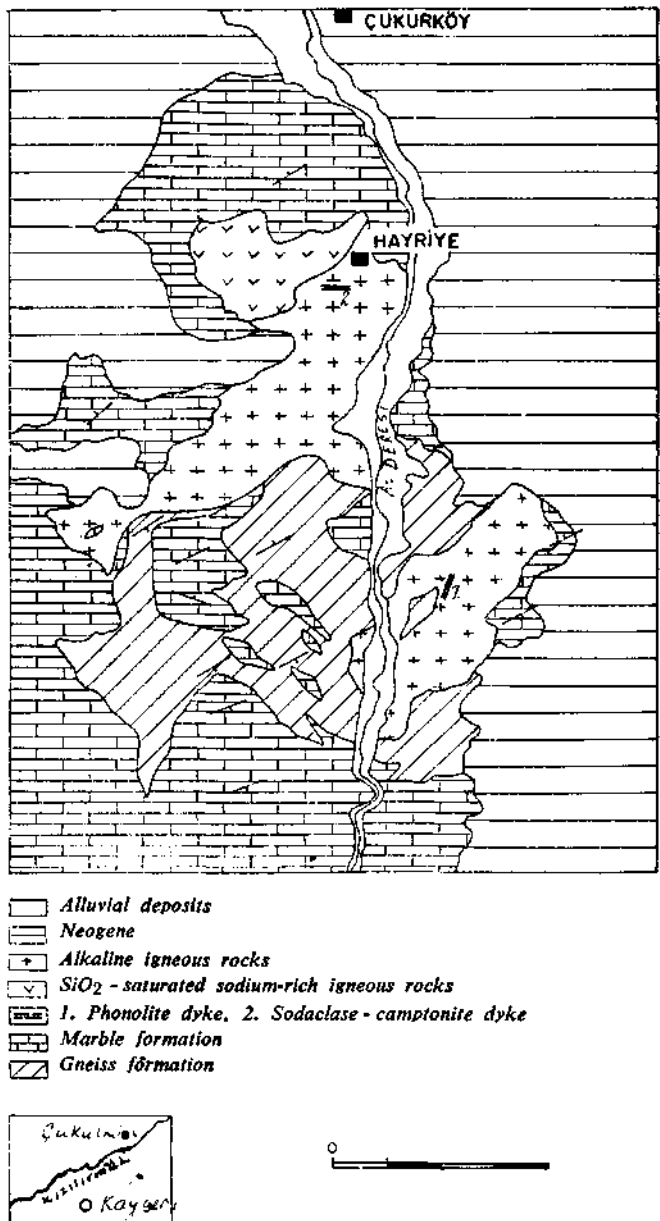
Sodaclase - syenodiorites consist of albite, a smaller amount of orthoclase, of biotite and of accessory hematite- and limonite grains.

Sodaclase - granodiorites consist of a large amount of albite, a smaller amount of orthoclase and of quartz. Further accessory limonite- and hematite grains occur.

Sodaclase-syenites consist of a large amount of kalifeldspars (microcline, isorthoclase, which are both perthitic), a smaller amount of albite, sericite pseudomorphs and of accessory muscovite, calcite, titanite, epidote, hematite- and limonite grains.

These SiO<sub>2</sub>-saturated sodium-rich rocks contain further rests of xenolithic limestone.

The characteristic of these rocks is a high content of Na<sub>2</sub>O, resulting in the occurrence of albite and a saturation of SiO<sub>2</sub> resulting in the occurrence of albite, orthoclase and sometimes of quartz.



**Fig. 1 - Geological map of the area of Çukurköy.**

2. *The alkaline igneous rocks.* — The alkaline igneous rocks are subdivided into the plutonic nepheline-syenites, the extrusive phonolites and the hypabyssal sodalase-camptonites.

The plutonic nepheline-syenites form the majority of rocks, while the extrusive phonolites were found only as a small dyke in the SE part of this igneous rock complex and the sodalase-camptonites were found as a small dyke in the NW part.

A deficiency in silica relatively to alkalis, resulting in the formation of low-silica minerals such as nepheline, sodalite and other feldspathoids is the main chemical feature in this rock group.

The principal constituent minerals are feldspathoids (nepheline, sodalite, cancrinite), kalifeldspars, ferromagnesian silicates (aegirine augite, biotite) and some minerals, such as melanite, which otherwise are rare but may rank here as essential minerals.

2a. *Nepheline-syenites:* The largest part of igneous rocks along the At Deresi consists of nepheline-syenites. Among these plutonic alkaline rocks could be distinguished: biotite-sodalite-syenites, aegirine augite-nepheline-syenites, nepheline-syenites, biotite-nepheline-syenites, melanite-nepheline-syenites.

Biotite-sodalite-syenites consist of a large amount of orthoclase, a smaller amount of sodalite, a very subordinate amount of green biotite, and of accessory melanite - and ore grains.

Some orthoclases are partly calcitized and sericitized and sodalite is sometimes altered into secondary zeolite.

Aegirine augite-nepheline-syenites consist of a large amount of nepheline, of a smaller amount of kalifeldspar (isorthoclase), of very subordinate amount of aegirine augite, of accessory melanite, of accessory calcite and of accessory marcasite, pyrite grains. In addition, some samples contain an accessory amount of biotite.

Nepheline is mostly fresh, but in some samples it is changed into zeolite, cancrinite or into sodalite. Sometimes nepheline is partly calcitized and sericitized.

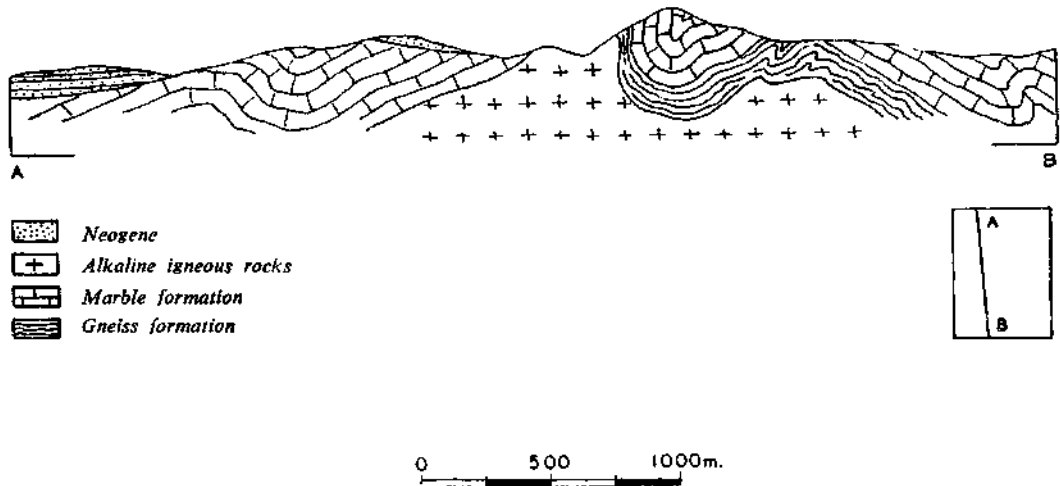
Nepheline-syenites consist of nepheline and kalifeldspar (isorthoclase, orthoclase or microcline). Some samples can contain further a subordinate amount of zeolite - muscovite pseudomorphs and an accessory amount of muscovite, pyrite and calcite.

Nepheline is mostly fresh, only in some samples nepheline is partly changed into sodalite or it is partly sericitized.

Biotite-nepheline-syenites consist of nepheline, kalifeldspar (orthoclase, microcline or isorthoclase) and of a small amount of biotite. Nepheline is mostly fresh, in some samples nepheline can be partly changed into sodalite, cancrinite, zeolite. As accessory minerals could be observed: tourmaline, pyrite, marcasite, magnetite, zircon, melanite and calcite.

Melanite - nepheline - syenites consist of nepheline, kalifeldspar (isorthoclase or orthoclase), of subordinate melanite and of subordinate zeolite or zeolite - sodalite pseudomorphs. Some samples contain accessory cancrinite, accessory biotite, accessory pyrite. The nepheline is mostly fresh, although in some samples it is partly sericitized or sodalitized.

2b. *Phonolites:* In the SE part of the alkaline igneous rock complex a small dyke of phonolite outcrops.



**Fig. 2 - NW-SE geological section of the Çukurköy area.**

The phonolites are to be considered as the extrusive equivalents of the nepheline-syenites. These porphyritic extrusive alkaline rocks are characterized by the mineral combination kalifeldspar and nepheline.

The phonolite shows a holocrystalline porphyritic texture. It consists of sanidine phenocrysts, diopside phenocrysts, sericite pseudomorphs and garnet, which are lying in a holocrystalline groundmass, consisting of numerous hypidiomorphic aegirine augite, biotite, interstitial xenomorphic nepheline and of accessory magnetite grains. The diopside phenocrysts are surrounded by narrow aegirine augite rims. The rock is slightly calcitized.

2c. Sodaclase-camptonites: A small dyke of a sodaclase-camptonite was discovered in the NW part of the alkaline igneous rock complex. This lamprophyre belongs also to the alkaline igneous rock complex because it contains nepheline.

The sodaclase - camptonite shows a panidiomorphic holocrystalline texture. It consists of a large amount of hypidiomorphic albite, of idiomorphic biotite, of idiomorphic diopside, of an accessory amount of nepheline and of an accessory amount of isorthoclase. The diopsides are bordered by a rim of aegirine-augite. The rock is slightly calcitized.

**C. Neogene and alluvial deposits**

The gneiss-marble formation and the igneous rock complex are unconformably covered by horizontal lacustrine Neogene sediments in part, and the course of At Deresi consists of alluvial deposits.

**III. PETROLOGICAL CONCLUSIONS**

Concerning the SiO<sub>2</sub>-saturated sodium-rich igneous rocks it is easy to understand that the petrogenetical connection between sodaclase-syenodiorites, sodaclase-granodiorites and sodaclase-syenites is due to a differentiation.

Concerning the alkaline igneous rocks their petrological origin is due to lime assimilation by the SiO<sub>2</sub>-saturated sodium-rich magmas. The alkaline magmas must be

generated wherever  $\text{SiO}_2$ -saturated sodium-rich magmas are intruded in the gneiss - marble formation. The binding of an amount of silica of albite of the original  $\text{SiO}_2$ -saturated sodium-rich magmas by the absorbed calcite of the marbles and the removal of the products by differentiation leads to such desilication of the magma as to cause the origin of feldspathoids (nepheline, etc.).

This process also facilitated the forming of calcium silicates as melanite. The alkaline magmas originated in this way by the process of lime assimilation of the original  $\text{SiO}_2$ -saturated sodium-rich magmas.

The well-known assimilation theory of R.A. Daly appears to be verified in the region of Çukurköy by the following facts :

1. The close association of the  $\text{SiO}_2$ -saturated sodium-rich igneous rocks and alkaline igneous rocks.
2. The intrusion of the igneous complex in the gneisses and marbles.
3. The occurrence of lime-bearing silicates in the alkaline rocks as melanite, cancrinite.
4. The occurrence of xenolithic limestone rests in the  $\text{SiO}_2$ -saturated sodium-rich igneous rocks.
5. The occurrence of apophyses of nepheline-syenites in the contact zone of the marbles.

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