

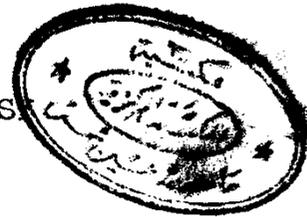
COMPARATIVE MINERALOGIC STUDIES OF PHOSPHATE
OCCURRENCES OF EGYPT, U.A.R.

Thesis Submitted to
Faculty of Science, Ain Shams University

By

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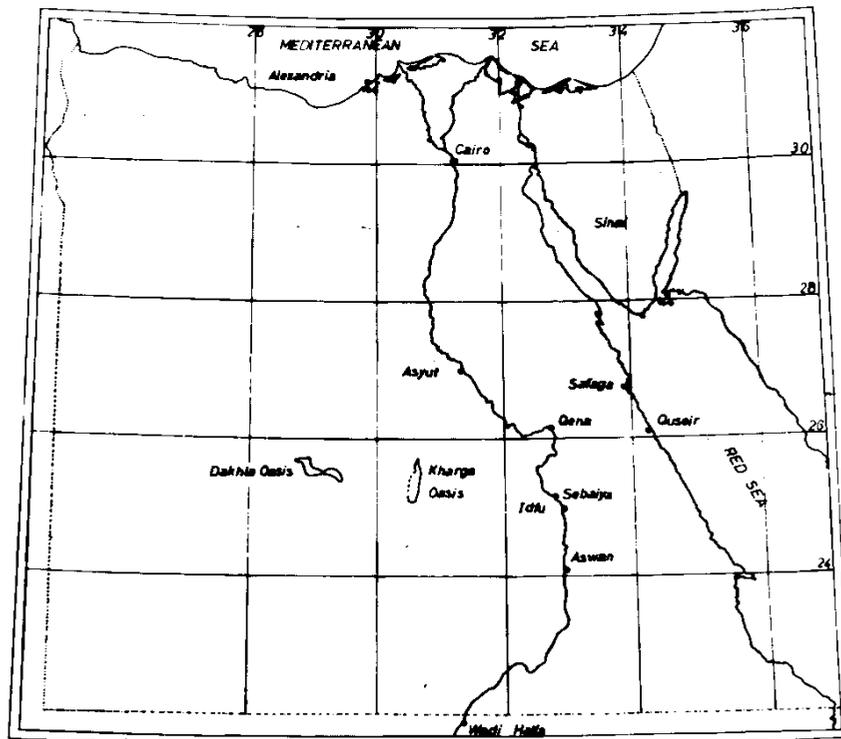


Fig. (1) Location Map.

INTRODUCTION

Phosphates are one of the vital ore deposits in the world. Their interest comes from their existence in rocks of almost all geological ages.

Sea water below the surface layers is virtually saturated with tricalcium phosphate. It is, of course, an exceedingly dilute solution, yet to maintain equilibrium much calcium phosphate must be deposited in marine sediments as is continuously added to the ocean by streams and springs. More calcium phosphate is also deposited in non-marine sediments. The total amount deposited is very large, but most of it is widely scattered as minor constituents in many sedimentary rocks. In some strata, however, calcium phosphate is concentrated, forming what are called phosphorites.

The most common form of sedimentary phosphates is collophane, a cryptocrystalline phosphatic substance producing x-ray patterns of apatite. It may consist of any several varieties of apatite.

Much collophane is organic, since the chief constituent of organic remains, e.g. bones, teeth and some marine shells, specially those of certain Brachiopods, which are widely scattered through many sediments. The fecal residues of many organisms are also phosphatic, and many ovoid phosphatic pellets in sediments have been attributed to this origin.

Inorganic collophane is also widespread. Many phosphates, for example, consist simply of sand, silt or clay cemented with collophane. Much inorganic collophane is probably an original precipitate, but some was formed by diagenetic replacement. Some calcareous shells and parts of some limestones have been replaced by collophane and in some places phosphorites have been formed by this process.

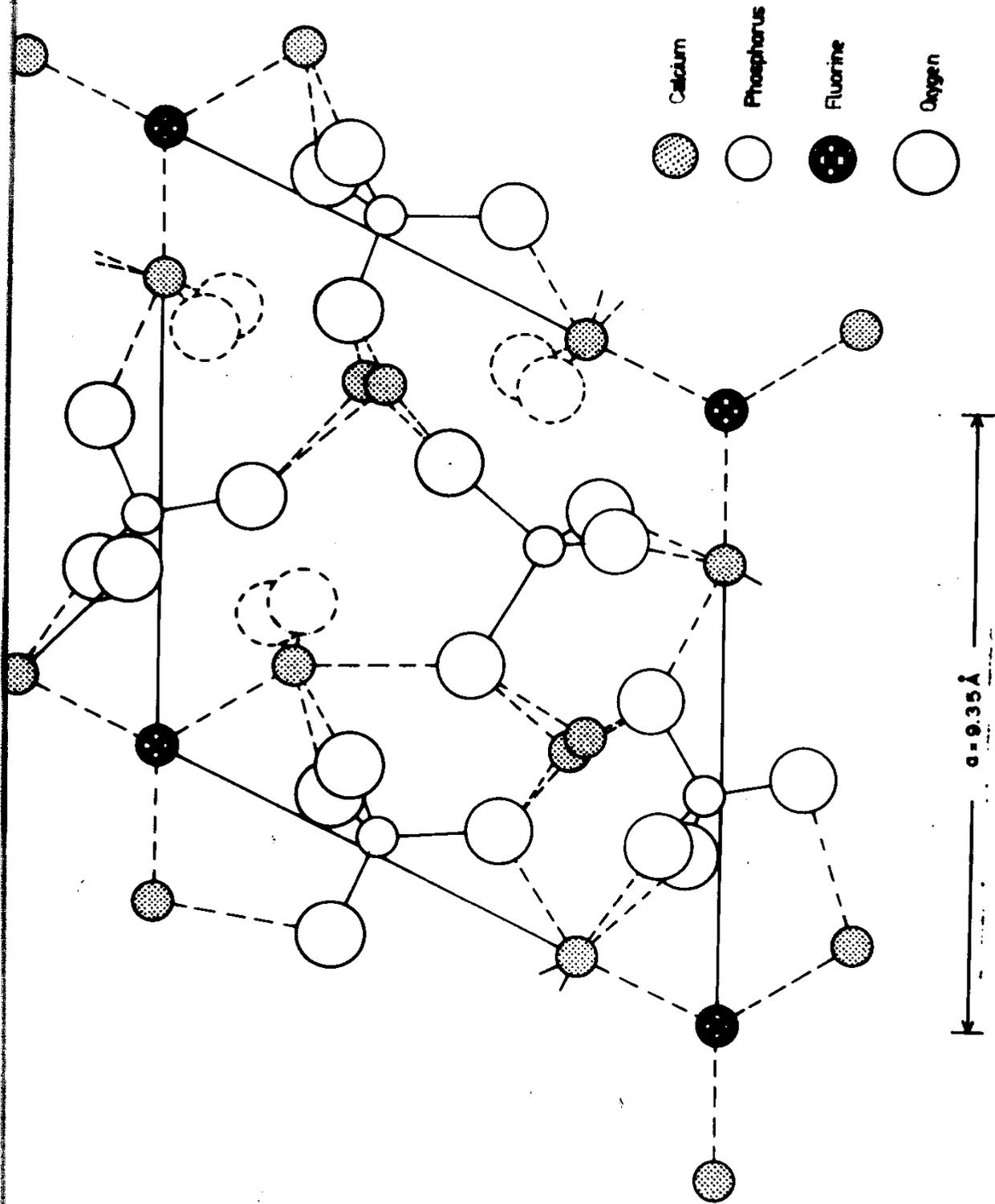
The apatite in the phosphorites is basically fluorapatite with significant and variable substitutions. The most common varieties are represented by the isomorphous series with the end members:

fluorapatite, $\text{Ca}_5 (\text{PO}_4)_3 \text{F}$,
chlorapatite, $\text{Ca}_5 (\text{PO}_4)_3 \text{Cl}$,
hydroxylapatite, $\text{Ca}_5 (\text{PO}_4)_3 \text{OH}$ and
carbonate apatite, $\text{Ca}_{10} (\text{PO}_4)_6 \text{CO}_3$.

Of these, the fluorapatite is the most common and the term apatite is sometimes used synonymously with fluorapatite. Each fluorine atom is surrounded by 3 calcium atoms at one level, and in addition Ca-O columns are linked with PO_4 groups forming a hexagonal network, Fig. (2).

Phosphate rocks constitute an important part of the Upper Cretaceous rocks of Egypt, exploited in some districts, exploitable in others and of lower grades in still other occurrences.

Fig. (2) Structure of fluorapatite.
(After Bragg, 1937).



Much work had been carried out on the Egyptian phosphates since that of Barron and Hume (1902) who concluded that the whole series of Esna shales are of Eocene age and that these rested unconformably over the Campanian beds which contain phosphates.

Hussein (1954) studied petrographically the phosphates of Sebaiya and Quseir and concluded that phosphates were deposited under epineritic conditions. There, exists a causal link between the formation of the phosphate deposits and the existence of strong marine currents that abraded the bottom of the shallow sea.

Rittman and Machu (1955) concluded that the formation of calcium phosphate took place by reaction between finely distributed calcium carbonate particles and dissolved ammonium phosphate coming from the decay of organisms in the presence of a stirring effect of the sea water.

Youssef (1957) proposed the name "Duwi formation" for the phosphate formation lying above the variegated shales and below the Esna shales.

Tarabili (1957) classified phosphates of Quseir and Safaga according to the shape of collophane grains and according to the cement.

Said (1961) gave the phosphate formation at Quseir together with the overlying shale and chalk, as well as the underlying variegated shale, a Maestrichtian age.

Fekry (1963) carried out geochemical studies on phosphate samples from Quseir, Safaga, Mahamid, Dakhla and Sebaiya west.

Philobos (1964) carried out a detailed petrographic study on phosphates of the Quseir- Safaga region.

Tablawey (1966) studied the phosphates of Dakhla and Kharga Oases by petrographic, x-ray, spectral, chemical and mechanical analyses.

Object of this thesis:-

No detailed mineralogical studies had been carried out on Egyptian phosphates. Most of the previous work was either stratigraphical or petrological. The main object of this thesis is to carry out a detailed comparative mineralogical study for the Egyptian phosphate occurrences. Using advanced investigation methods as x-ray analysis, thermogravimetric analysis, differential thermal analysis and infrared analysis as well as the petrographic study, a clear idea about the mineralogical composition of Egyptian phosphates was given. The studies were carried out on Nile Valley, Quseir, Safaga, Dakhla Oasis, Kharga Oasis and Sinai phosphates. Also some samples from the Russifa area in Jordan were studied.

Occurrences and sampling:-

The phosphate bearing beds of the following different occurrences are briefly described, mainly, after Said (1962)

In the Nile Valley district, the bone beds overlying the variegated shales and underlying the Dakhla shales become phosphatic at El-Mahamid. On both sides of the Nile, in the Sebaiya district, the phosphate beds occur immediately below the alluvium covering the surface of the plain which extends between the cultivated land and the desert hills. Nearly 3m of gravels and blue clay overlies a phosphate bed, the thickness of which varies from 30 - 60 cm; this bed has an average tricalcium phosphate content of 40 percent. From this bed, samples N1 -N7 and N44 - N67 were collected from East 3 and West 1 mines.

Gebel Aweinia is a hill (450 m high) lying about 8.5 km to the Northeast of Sebaiya railway station. Here, the phosphate formation overlies the variegated shale and underlies the Dakhla shale. It is a bone and coprolite bed with *Ostrea villei*. From this district, samples N8 and N68 - N82 were collected.

In the Qena - Quseir road and in Safaga district, the Quseir variegated shales are overlaid by a distinct unit composed of hard semicrystalline or siliceous limestone, marl beds and a number of lenticular phosphatic bands. The

formation is about 66 m in thickness in the Atshan area. It was given the name "Duwi formation" by Youssef (1957). The phosphate bands can be grouped into three horizons:

i- The top phosphatic bed "Atshan bed" is exploited at Atshan, El-Daba and El-Nekheil mines. The thickness of this bed varies from 160 - 170 cm and the tricalcium phosphate content is between 65 and 70 percent. From this bed, samples Q19, Q20 and Q22 - Q25, from the Nekheil mine, were studied.

ii- The middle phosphatic bed, which lies below the Atshan bed, has a thickness of 150 cm and a tricalcium phosphate of about 70 percent and is exploited at the Duwi mine from which samples Q16 and Q21 were studied.

iii- The lower phosphatic bed is exploited at Hamadat mine where it has a thickness of about 3 m; it has a tricalcium phosphate of 60 - 64 percent. From this mine, samples Q14, Q15 and Q17 were studied.

From Safaga district, sample F13 was studied.

The Dakhla Oasis forms a depression that lies about 120 km west of the Kharga Oasis and about 300 km west of the Nile Valley. There are five rock units that make the formations of this oasis. These are, from top to bottom as follows:

Chalk,
Dakhla shale,
Phosphatic beds,
Variegated shales and
Nubian sandstone

The phosphatic beds cover large parts of the foot scarp of the northern cliff of the oasis. The actual phosphatic bands underlie the Dakhla shales in the form of several distinct bands, separated by different intervening beds of shale. The average total thickness of the phosphatic rocks ranges from 2 - 3 m. The rock itself is usually dark brown in colour, and appears to be made largely of coprolites and broken - up bones, including bones of fairly large vertebrae and numerous fish teeth. From this phosphate rock, samples D18 and D26 - D32 were studied.

The Kharga Oasis forms a depression lying about 200 km from the Nile Valley between latitudes 25° and 26° N. The geological formations found in Kharga belong to the following units from top to bottom:

Travertines and loess deposits
Thebes formation
Esna shale
Chalk
Dakhla shale