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Petrography of the Triassic Phosphorites in Gharyan Area, NW Libya

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بتروغرافية صخور الفوسفورايت التابعة للحين الترياسي بمنطقة غريان – شمال غرب ليبيا

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أوضحت هذه الدراسة البتروغرافية أن رسوبيات فوسفات منطقة غريان بشمال غرب الجماهيرية تتواجد في الجزء السفلي من تكوين أبوشيبة الذي يرجع عمره إلى الدور الترياسي حيث وجد أنها عبارة عن مجموعة من مكونات فوسفاتية من الكريّات وبقايا عظام الأسماك والبيفتات والأنتركلاست والكبروليت وأخرى غير فوسفاتية تتمثل في خليط من حبيبات كلسية ومن المرو والفلدسبار وتوضح الدراسة البتروغرافية أن رسوبيات الفوسفات كانت قد تكونت أولاً كفوسفات طيني ثم أعيد ترسيبها كفوسفات غني بالرمل.

Abstract *The studied Triassic phosphorites are located in Gharyan area, north-western Libya. The phosphorites form the lower part of Abu Shaybah Formation, and are composed of phosphate elements, such as pellets, micronodules, intraclasts, coprolites and bone fragments plus a mixture of carbonate and quartz grains. Petrographic study of the Gharyan Triassic phosphorites shows that they were formed by deposition as phosphate mud, followed by reworking and redeposition as phosphate sands.*

INTRODUCTION

Ayler (1967) compiled the previous work on the phosphate occurrences in a bulletin for the Ministry of Industry in which he concluded that if commercial phosphate deposits exist in Libya, they would not be easily found. In 1973, the Industrial Research Centre (I.R.C.) carried out (through Polservice) a systematic exploration programme covering four areas in NW Libya. The study included sedimentary rocks of Late Cretaceous to Miocene age, but only a few phosphatized pelecypod shells were noticed. After a quick visit to NW Libya, through the Bureau de Recherches Geologiques et Minieres (B.R.G.M.), Slansky (1974) thought that there were some chances of discovering new phosphate deposits in Gharyan area. In the course of mapping (Tarabulus Sheet at a scale of 1:250 000) El Hinnawy and Cheshitiv (1975) reported the presence of phosphate bands at the top of Al Aziziyah Formation in Gharyan dome and Al Khurmat al Hamra dome. This study presents both petrography and field observations, as very little is as yet known.

GEOLOGICAL SETTING

In the study area the Mesozoic sedimentary sequence shows considerable variation in lithology and thickness, which reflects the shifting of sedimentary environments both laterally and vertically. The Early Triassic rocks are poorly exposed and indicate a continental environment with the development of red micaceous sandstone and siltstone facies. The Middle Triassic sequence shows a mixture of carbonate and terrigenous lithology formed

in an alternating near-shore marine to continental environment. The Late Triassic sediments were deposited in a continental environment that gradually shifted to a shallow water marine environment. (El Hinnawy and Cheshitev, 1975; Fatmi *et al.*, 1978). There are a few prominent domes in the study area which brought the Triassic formations to the surface. These formations are commonly cut by faults (Fig. 1).

Kurrush Formation

Kurrush Formation consists locally of red to brown, fine-grained, micaceous, and glauconitic sandstone. It is poorly exposed and only the upper 23.5 m are exposed (Fig. 2). The contact between Kurrush Formation and the overlying Al Aziziyah Formation is transitional. The upper unit of Kurrush Formation consists of sandy limestone The environment of deposition of this formation was sublittoral and the changes in lithology were related to the fluctuations in sea level (Desio, *et al.*, 1960; 1963; Burrollet, 1963; El Hinnawy and Cheshitev, 1975).

Al Aziziyah Formation

Al Aziziyah Formation consists lithologically of well-bedded limestone characterised by its dark grey colour. The limestone is partly siliceous and partly dolomitic with common clay and chert beds. The thickness of Al Aziziyah Formation in the study area is about 120 m (Fig. 2). Its depositional environment is relatively quiet, water inner shelf environment as indicated by its fossil assemblage (Christie, 1955; El Hinnawy and Cheshitev, 1975).

Abu Shaybah Formation

The Abu Shaybah Formation consists locally of a thin unit of a phosphatic breccia with angular to subrounded grains in the base and cross bedded sandstone in the upper part. The latter is white, red and yellow in colour alternating with green and red bands of clay. The thickness of the formation in the study area is 105 m (Fig. 2). The depositional environment of Abu Shaybah Formation is mainly continental with shallow water, marine to lagoonal

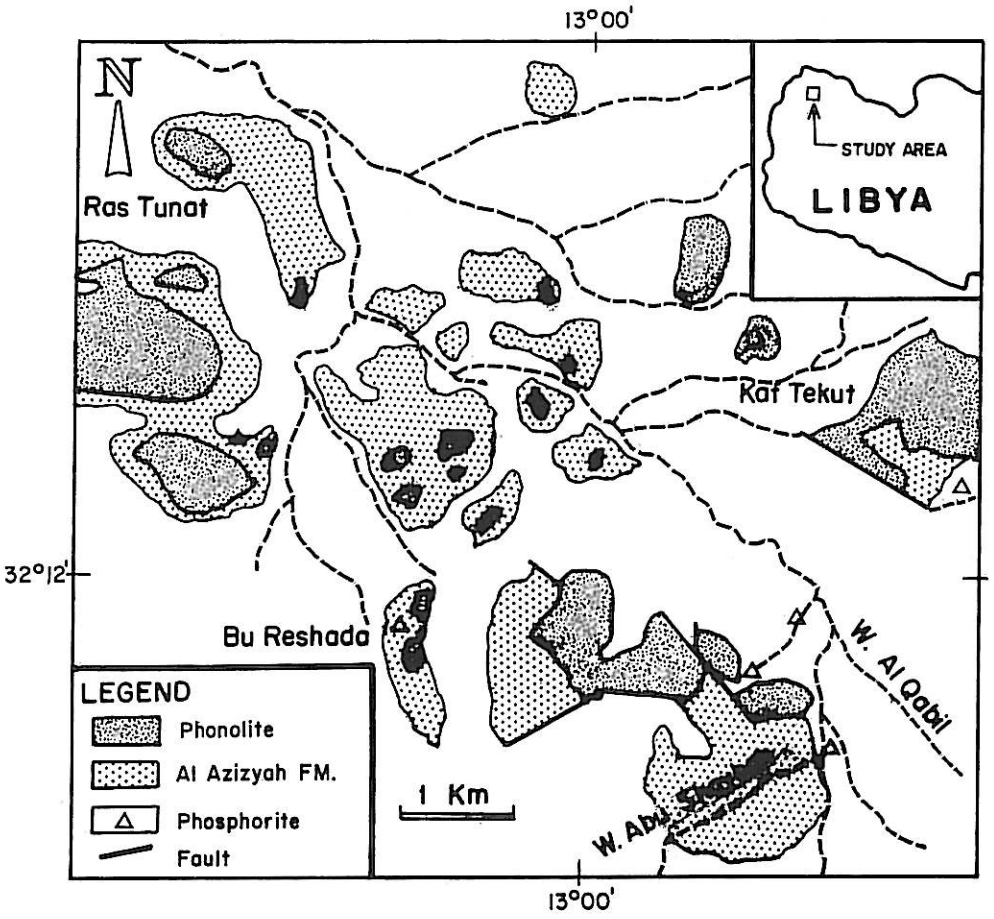

Fig. 1. Geologic map showing location of the Gharyan phosphorite.

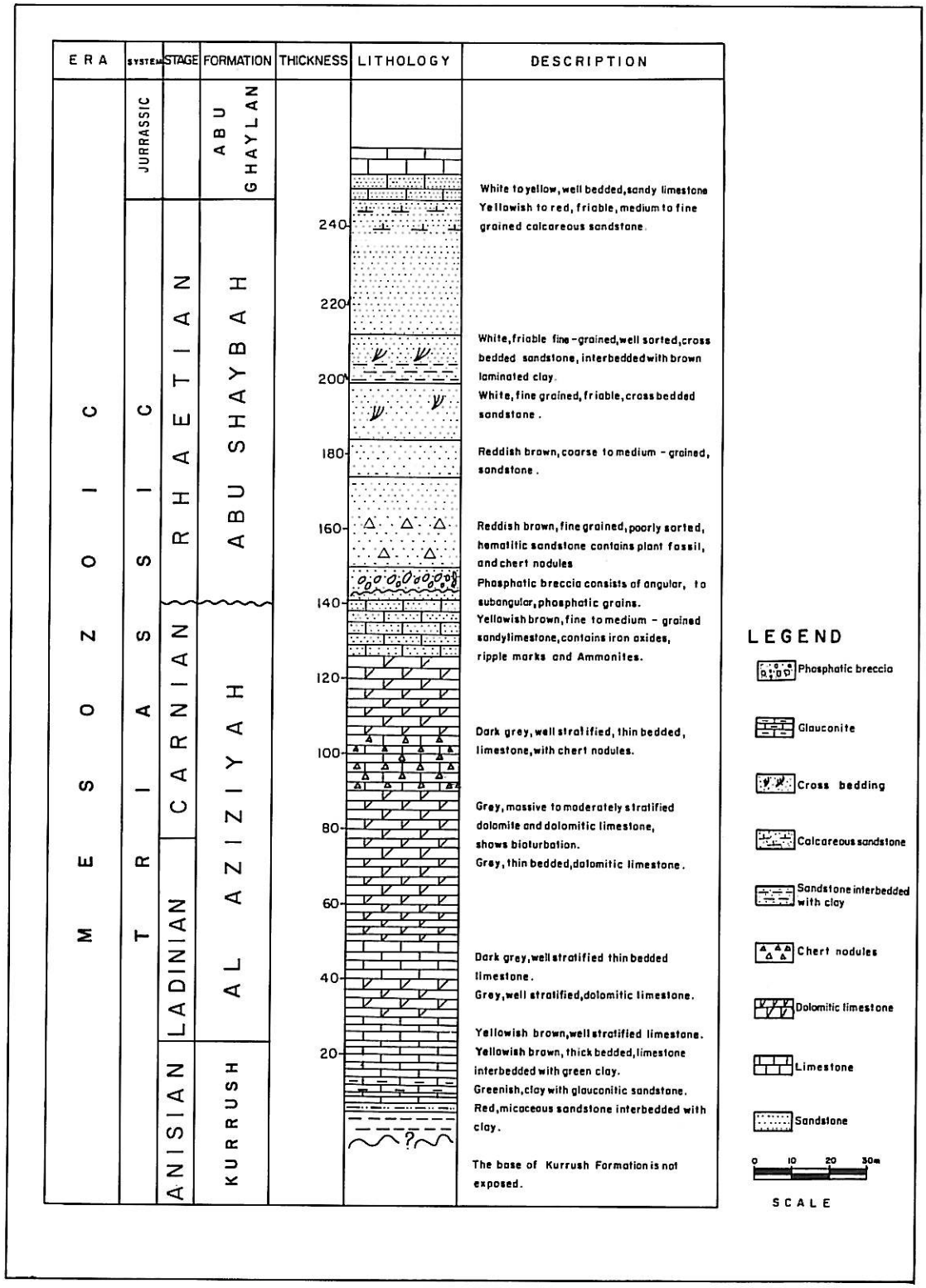

Fig. 2. Stratigraphic section of the Triassic formations in Gharyan area.

and coastal lake facies, particularly in the upper part (Desio, *et al.*, 1960, 1963; El Hinnawy and Cheshitev, 1975; Fatmi *et al.*, 1978).

THE PHOSPHORITES

During their systematic mapping of Tarabulus Sheet, El Hinnawy and Cheshitev (1975) reported

the presence of phosphate bands and described them as the upper part of the marine limestone of Al Aziziyah Formation. The present study suggests that the phosphorite sediments, which overlie the surface unconformity of the upper part of Al Aziziyah Formation, belong to the lower member of Abu Shaybah Formation.

The phosphorite bands show a variation in thickness ranging from 3.9 m at Wadi al Qabil (Fig. 3a) to less than 0.5 m at Kaf Tekut. In Bu Reshada and Ras Tunat areas the phosphorite bands are 0.5 m thick.

PETROGRAPHY

Megascopically the phosphorites are coarse-grained, light brown to light grey in colour with a micro-conglomeratic texture. They include phosphatized pelecypods, gastropods, fish teeth, and bone fragments (Fig. 3b). Most of the phosphorites under consideration show good compaction and poor to moderate sorting. Using Slansky's classification (Slansky, 1986), the Gharyan Triassic phosphorites are mainly phospharenite and phospharudite with some quartz- phospharenite. In thin sections under the microscope phosphatic and non-phosphatic elements and cement can be distinguished.

A-Phosphatic Elements

Pellets

The Gharyan phosphorites show pellets that range from 10% to 15% of the phosphorites in Wadi al Qabil. The grain size ranges from 0.5 to 1.2 mm. The pellets are mostly broken but complete units are sometimes seen (Fig. 4d). Except for very few fine quartz grains no nuclei were noticed in most of the

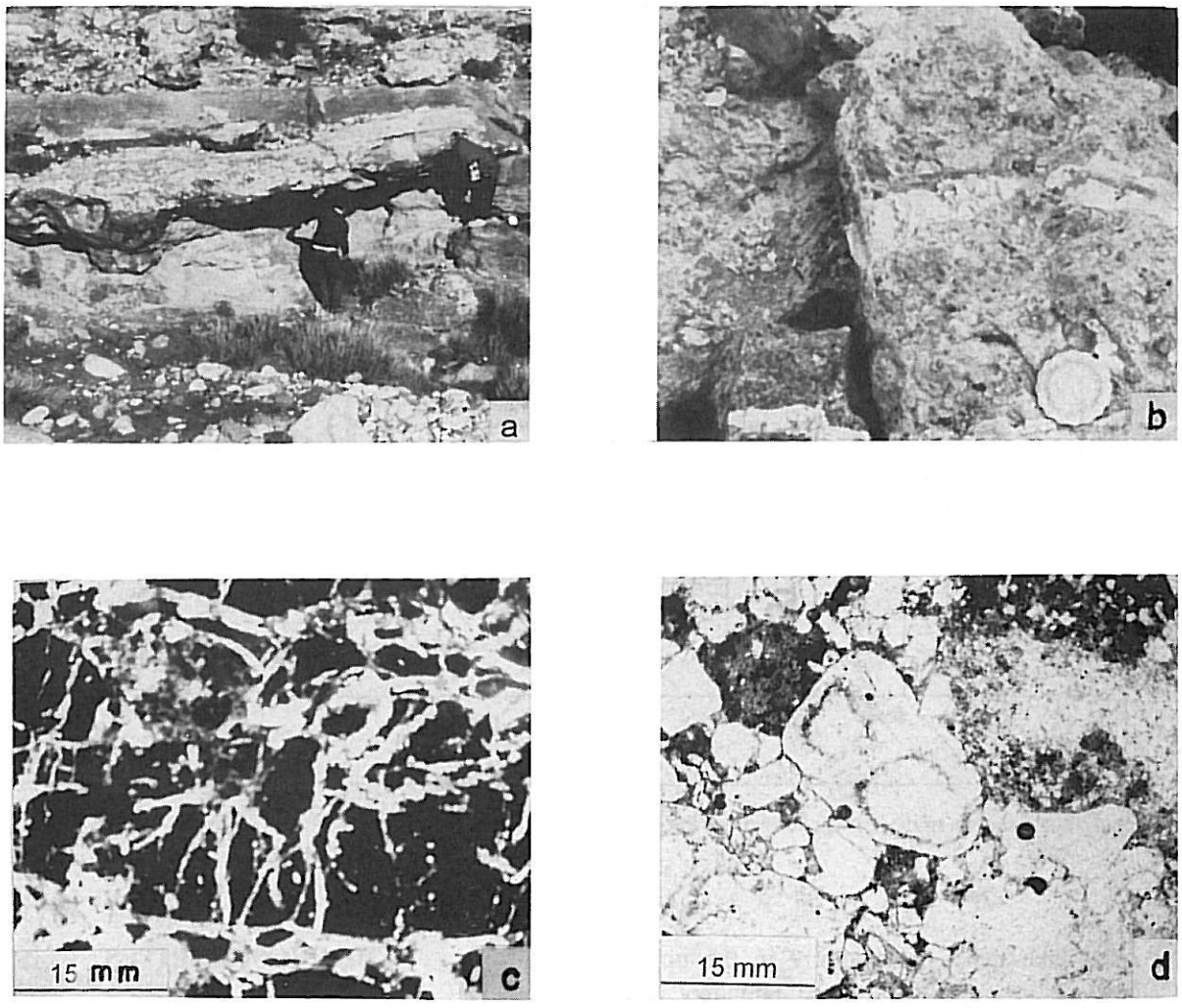

Fig. 3. Phosphorite outcrop in Wadi al Qabil; (b) Bone fragment for aryan phosphorites; (c) Broken pellet filled with microsparite; (d) Microfacies of Gharyan phosphorite pellet showing some organic matter.

examined pellets.

The broken pellets are filled with microsparite (Fig. 3c). Some of the pellets contain organic matter (Fig. 3d). Some others show calcification in the boundaries and less calcification inside. This may be due to chemical substitution.

Micronodules

The micronodules range from 10% to 15% of the studied phosphorites of Gharyan area. The grain size of the micronodules of all the phosphorites ranges from 0.6 to 2.0 mm.

They are composed of rounded to subrounded grains. Their boundaries are broken and the fillings are made of fine grains of quartz, micrite, and microsparite.

Intraclasts

The irregular phosphate elements represent about 4% to 15% of the total component. The grain size of the phosphatic interclasts ranges from 0.4 to 1.8 mm. The endogangue and the exogangue in the intraclast are of fine to medium quartz grains with microsparite, and fine bone fragments, showing some organic matter.

Coprolites

The coprolites represent less than 10% of the total components in most of the examined sections from Gharyan area. (Fig. 4a). Their grain size ranges from 0.2 to 0.7 mm.

Bone fragments

The amount of bone fragments in these phosphorites ranges from 4% to 10%. The studied phosphorite specimens were found to contain broken and fractured vertebrate bone fragments. These fragments are elongated, and filled with microsparite.

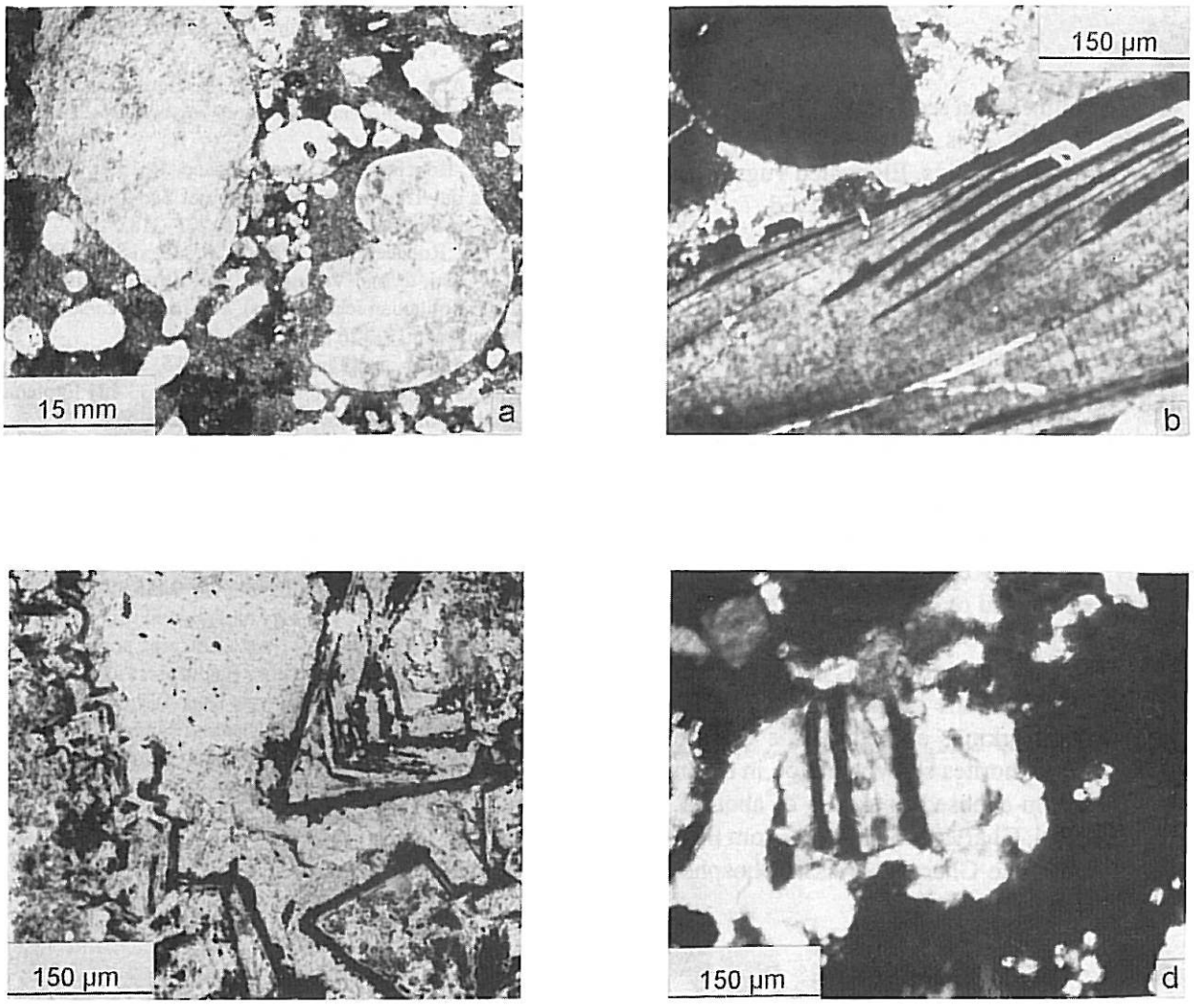

Fig. 4. Microfacies showing (a) coprolite, (b) fish scale, (c) secondary dolomite and (d) plagioclase grain.

The phosphatic sediments are rich in fish teeth and fish scales (Fig. 4b).

B-Other (non-phosphatic) Elements

The main other elements (non-phosphatic) are quartz, feldspar and some carbonate pellets, interclasts, and lithoclasts.

Quartz

Rounded to subrounded, abundant quartz grains represent about 15% of the total volume in the studied phosphorite. The quartz detritus are cemented by calcite and hematite. Some of the detritus are made of secondary dolomite. (Fig. 4c).

Feldspar

The studied phosphorites show grains of plagioclase and microcline. The plagioclase grains occur mostly as exogangue elements and have euhedral form (Fig. 4d). The microcline grains are endogangue in some pellets of the studied phosphorites.

C-Cement

In the examined thin sections cement forms more than 20% volume. It is mainly sparite with some hematite around the grains. Elongated vugs filled by small quartz detritus were also observed.

GENESIS AND CONCLUSION

The studied Triassic phosphorite is coarse-grained, light brown to light-grey in colour with a micro-conglomeratic texture. It includes a phosphatized fauna of pelecypods and gastropods with fish teeth and bone fragments. This phosphorite is generally composed of phosphatized structureless diagenetic grains and ovules with rectangular skeletal grains as intraclasts, together with subangular detrital fine-grained quartz and very fine-grained carbonate cement. Some of the quartz grains show evidence of reworking, especially the exogangue grains. The phosphorites show variation in thickness with a maximum exposed thickness of about 3.9 m in Wadi al Qabil, Gharyan dome area. From this petrographic study, the Gharyan Triassic phosphorites seem to have been formed first by deposition as a phosphate mud and then reworked and redeposited as phosphate sands in a shallow marine environment. The phosphorite particles show deformation as a result of late tectonic movement (faulting and doming) associated with the central Jabal Nafusah uplift. The faults and domes have no relation with the mineralization. The presence of the euhedral feldspar grains is an indication that the phosphorites did not suffer transportation for a long distance. This suggests that the feldspar and phosphorite grains originated from the same area.

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