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Geochemistry and microprobe investigations of Abu Tartur REE-bearing phosphorite, Western Desert, Egypt

Gamal S. Awadalla *

Nuclear Materials Authority, P.O. Box 530, El-Maadi, Cairo, Egypt

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ABSTRACT

Phosphorites in Egypt occur in the Eastern Desert, the Nile Valley and the Western Desert at Abu Tartur area and present in Duwi Formation as a part of the Middle Eastern to North African phosphogenic province of Late Cretaceous to Paleogene age (Campanian–Maastrichtian). The Maghrabi-Liffiya phosphorite sector is considered as the most important phosphorite deposits in the Abu Tartur area due to its large reserve thickness and high-grade of lower phosphorite bed beside high content of REE. Back scattered electron (BSE) images show framboidal pyrite filling the pores of the phosphatic grains, suggesting diagenetic reducing conditions during phosphorites formation.

Electron Probe Micro Analyzer (EPMA) chemical mapping was conducted to examine the variation and distributions of selected elements (P, F, La, Fe, Yb, Si, Ce, W, Eu, S, Ca, Y and Er) within the shark teeth, coprolites and bone fragments. In the teeth W, S, Fe are concentrated along the axis of the teeth, the bone fragments show high concentration of W, Yb, Er and Eu, whereas coprolites are nearly homogenous in composition contains S, Er with some Si as micro-inclusions. Fluorapatite is considered as main phosphate mineral whereas pyrite occurs as pore-filling within the phosphatic grains and cement materials. Maghrabi-Liffiya samples show a wide range in the P_2O_5 content, between 19.8 wt.% and 29.8 wt.% with an average of 24.6 wt.% and shows low U content ranging from 15 ppm to 34 ppm with an average of 22 ppm. The total REE content in nine samples representing the Maghrabi-Liffiya ranges from 519 to 1139 ppm with an average of about 879 ppm. The calculation of LREE (La–Gd) show indeed a marked enrichment relative to the HREE (Tb–Lu) where LREE/HREE ratio attains 8.4 indicating a strong fractionation between the LREE and HREE. Chondrite-normalized REE patterns of the studied phosphorite samples show a negative Eu anomaly.

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1. Introduction

The phosphorite deposits of Egypt are widely distributed in the Eastern Desert, along the Nile Valley as well as in the Western Desert in Abu Tartur area (Fig. 1). These deposits belong to the Duwi Formation and constitute a part of the Middle Eastern to North African phosphogenic province of Late Cretaceous to Paleogene age (Campanian–Maastrichtian). The ore is subdivided into high-grad ores (not less than 26 wt.% P_2O_5), medium-grad ores (23–26% P_2O_5) and low-grad ores (less than 23 wt.% P_2O_5), the phosphorites are generally known to be those rocks containing more than 19.5 wt.% P_2O_5 (>50 apatite, Slansky, 1986). In fact, the problem of Abu Tartur is not the grade or the quality of the ore, also not problem of transportation distance but it is definitely mining problem due to the soft shale member that overlaying the phosphate member. The Abu Tartur mine extend about 1200 m. inside the Abu Tartur plateau. The recent work depend on open cast mining, where the excavation takes place in the Maghrabi-Liffiya scarp, that has the highest thickness of the ore in the whole plateau.

Abu Tartur phosphorites are considered as highest-grade in Egypt (attain average of 25 wt.% P_2O_5) and considered as one of the most important factors in development in Abu Tartur area. Preliminary exploration of the mining area (about 108 km^2) led to an estimation of 987 million tons as economic reserve with an average of P_2O_5 content not less than 25 wt.%. (Wassef et al., 1977). This work deals with the petrographical and mineralogical characteristics of different phosphate constituents beside examinations of polished sections by electron microprobe analyzer (EMPA). Chemical mapping was conducted to examine the distribution of the elements within the phosphatic grain and discussed the geochemistry of major, trace and REEs of Maghrabi-Liffiya sector at Abu Tartur plateau.

2. Geological setting of Abu Tartur phosphorites

Phosphorites of Egypt present in Duwi Formation as a part of the Middle Eastern to North African phosphogenic province of Late

* Tel.: +20 2 27585835; fax: +20 2 27585832.
E-mail address: aw_gamal@yahoo.com.

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Cretaceous to Paleogene age (Campanian–Maastrichtian). The phosphate bearing strata in Eastern Desert are known as Duwi Formation (Youssef, 1957), in the Nile Valley as Sibaiya Phosphate Formation and in the Western Desert as Phosphate Formation (Awad and Ghobrial, 1966). Three members of phosphorite beds are generally referred to as the lower, middle and upper members and they attain different economic values in different localities in Egypt.

The southwestern corner of Egypt, Sinai and along the Red Sea coasts are covered by the Upper Cretaceous-Lower Cenozoic sedi-

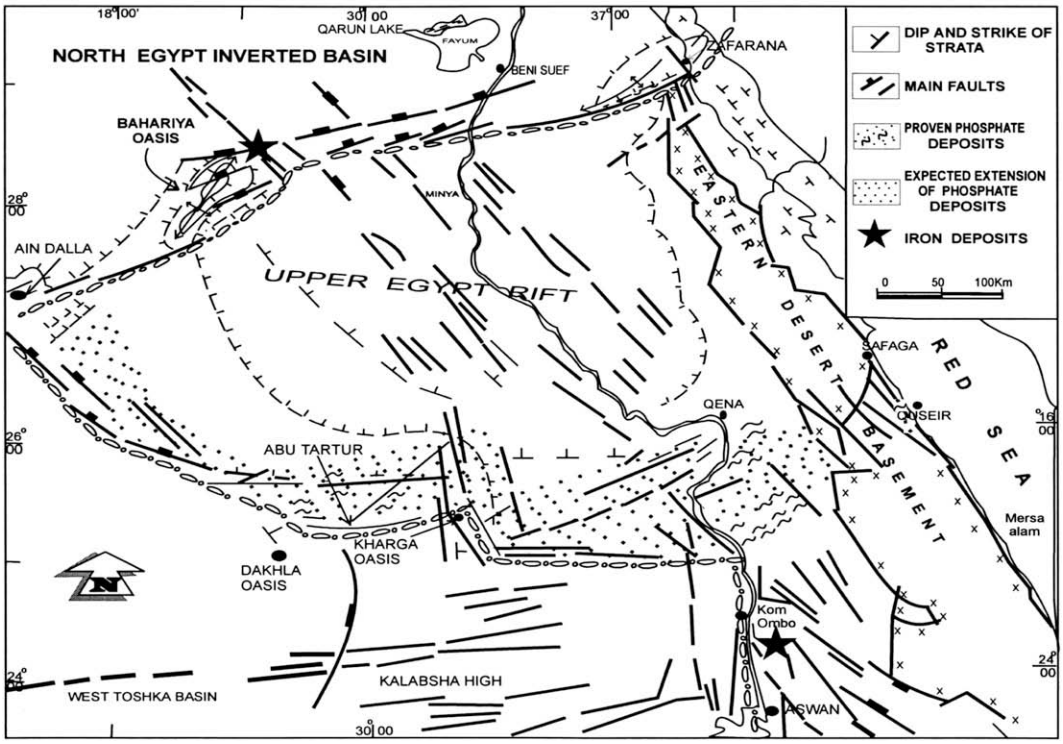

Fig. 1. Distribution of the iron and phosphate deposits in Egypt. After Khalil and Denchi (2000).

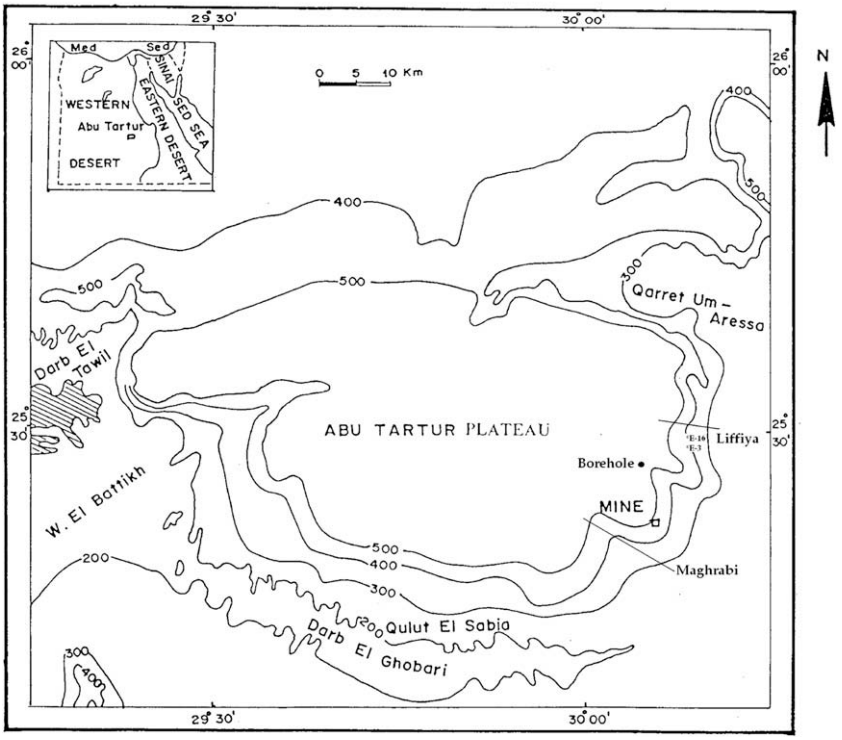

Fig. 2. Key map of Abu Tartur plateau showing the borehole and samples location at Maghrabi-Liffiya sector (modified after Zidan, 1998).

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