

Effect of the depositional environment on the compositional variations among the phosphorite deposits in Egypt

H.M. Baioumy *

School of Physics, Universiti Sains Malaysia (USM), 11800 USM, Pulau Pinang, Malaysia

Received 8 November 2011; accepted 21 June 2012

Abstract

Late Cretaceous economic phosphorites from the Red Sea, Nile Valley, and Abu Tartur areas, Egypt, show distinct variations in the lithology of associated sediments, mineralogy of nonphosphatic constituents, and distributions of major and trace elements. In the Red Sea area, the phosphorite beds are intercalated with laminated black shales, and the nonphosphatic constituents are detrital quartz and calcite, ankerite, and pyrite cements. In the Nile Valley, the phosphorite beds are intercalated with chert, marl, and sandstone and the nonphosphatic constituents are detrital quartz and calcite and chalcedony cements. In the Abu Tartur Plateau, the phosphorite beds are intercalated with laminated black shales, and the nonphosphatic constituents are detrital quartz and ankerite and pyrite cements. The phosphorites studied also show distinct variations in major- and trace-element concentrations. The Abu Tartur phosphorites have higher contents of TiO_2 , Al_2O_3 , Fe_2O_3 , K_2O , Co , Nb , Pb , Sr , Th , Y , and Zr and lower SiO_2 , Ba , and U contents as compared to those in the Red Sea and Nile Valley areas. The positive correlations between Al_2O_3 and TiO_2 , K_2O , Nb , Y , and Zr suggest the detrital origin of these constituents.

Similarity in the phosphatic constituents, which were derived from outside the depositional sites, and variations in the lithology of associated sediments and the mineralogy and geochemistry of the nonphosphatic constituents, which reflect the conditions at the depositional sites, suggest that the variations in the depositional environment of the phosphorites are the potential controlling factor of the compositional variations among these phosphorites. The abundance of black shales in the Red Sea and Abu Tartur areas, as well as the occurrence of ankerite and pyrite as cementing materials for the phosphatic constituents, might reflect reducing conditions in these areas, while the abundance of siliciclastic sediments and calcite and chalcedony cements suggests oxidizing conditions in the Nile Valley. The reducing conditions in the Red Sea and Abu Tartur areas were probably developed within the pre-existing depressions in a shelf environment. These depressions might have formed as a result of a change in the movements of the North Atlantic, Eurasian, and African Plates during the late Santonian, which led to transgressive inversion of rifts along northern Egypt and consequent folding in the continental interior. The higher contents of detrital components in the Abu Tartur phosphorites compared to the Red Sea and Nile Valley areas suggest more detrital inputs during the deposition of the phosphorites in Abu Tartur. The products of the diagenesis and weathering of these deposits also reflect the variations in the depositional conditions.

© 2013, V.S. Sobolev IGM, Siberian Branch of the RAS. Published by Elsevier B.V. All rights reserved.

Keywords: phosphorites; lithology; composition; depositional environment; Egypt

Introduction

The composition of sedimentary phosphorites is highly variable. Many authors (Bliskovski et al., 1967; Jarvis et al., 1994; Lehr et al., 1967; McArthur, 1978; McClellan and Lehr, 1969; Smith and Lehr, 1966) have attempted to explain the variability in terms of environmental factors working during phosphogenesis or in terms of postformational alteration (McArthur, 1985). Whippe and Murrowchick (1967) suggested that an unspecified environmental influence during phosphorite formation was responsible for the chemical vari-

ations between several phosphate deposits in the United States. Bliskovski et al. (1967) presumed that the variable Sr/Ca ratios at and between many phosphate deposits, mainly in the Soviet Union, reflect the Sr/Ca ratios in the depositional waters. Tambiyev (1979) explained the differing Sr/P₂O₅ ratios of phosphorite from Pacific seamounts and those of authigenic samples from Peru, Chile, and Namibia as resulting from different mechanisms of formation, with a subaerial process involved in forming the seamount phosphorite. Prévôt and Lucas (1980) presumed that the variable Sr/P₂O₅ ratios of Moroccan phosphorites result from the phosphatization of a mixture of low-Sr calcite and high-Sr aragonite. Gulbrandsen (1966) suggested that the range of phosphorite composition in the Phosphoria Formation might reflect a range of marine or

* Corresponding author.

E-mail address: hassanbaioumy@hotmail.com (H.M. Baioumy)

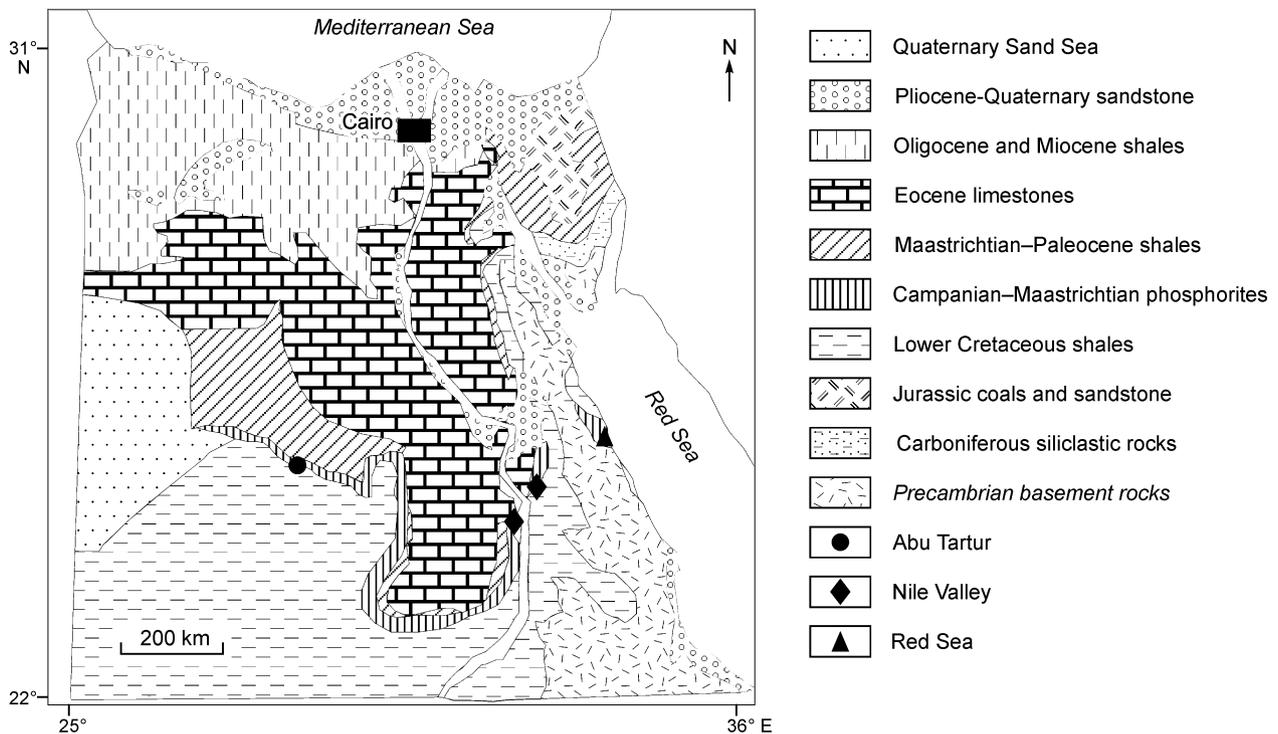


Fig. 1. Geological map of Egypt with the study areas, modified after (Spanderashvilli and Mansour, 1970).

possibly early diagenetic environments. Cook (1972) proposed that the chemical differences between three phosphorite types in Queensland might be related to weathering. Lucas et al. (1980) interpret variations in the composition of Moroccan and Senegalese phosphorites in terms of meteoric alteration and weathering.

Late Cretaceous phosphorites in Egypt, which make up part of the Middle East to North Africa phosphogenic province with more than 3 billion tons of reserves, are widely distributed in the Eastern Desert, Western Desert, and Nile Valley (Baioumy and Tada, 2005; Glenn and Arthur, 1990). They are produced for domestic uses as fertilizers and exported as raw material from three main areas: the Red Sea, Nile Valley, and Abu Tartur. This article showed the similarities and differences between the economic phosphorites in three main localities through the detailed mineralogical and geochemical analyses of the phosphatic and nonphosphatic constituents. The possible controlling factors of the compositional variations among these phosphorites were also discussed.

Geologic position

The phosphate-bearing Duwi Formation overlies a fluvial-shale sequence of the middle Campanian Qusseir Formation and is overlain by the deeper seated marine shales and marls of the middle Maastrichtian Dakhla Formation (e.g., Baioumy and Tada, 2005; Glenn and Arthur, 1990). Thus, deposition of the Duwi Formation is part of early Late Cretaceous marine transgression in Egypt. The precise age of the Duwi Formation

is poorly known and generally considered to be late Campanian or early Maastrichtian based on paleontological evidence (Glenn and Arthur, 1990).

The economic phosphorite deposits in Egypt are exploited in three main localities: the Red Sea, Nile Valley, and Abu Tartur (Fig. 1). According to Baioumy and Tada (2005), the Duwi Formation in these three areas is subdivided into four members based on its lithology (Fig. 2). The lower member is composed of coarse-grained phosphatic sandstone in Abu Tartur and of quartzose sandstone and siliceous shale in the Nile Valley and Red Sea areas. The middle one consists of soft laminated organic-rich black shale in all three areas. The upper one is composed of coarse-grained glauconitic sandstone in Abu Tartur, of phosphatic sandstone in the Nile Valley, and of phosphatic sandstone and oyster calcarenite in the Red Sea area. The uppermost member is composed of hard massive grayish brown to gray shale in all three areas. Individual phosphorite beds in the Duwi Formation range in thickness from a few millimeters to tens of centimeters. Thicker phosphorite beds consist of thinner ones. The thickest accumulation of minable phosphorites occurs in the lower member in Abu Tartur, where the phosphorite beds locally form a single seam (average thickness ~12 m). Nearly all the Duwi phosphorites underwent extensive bioturbation. As a result, most of the phosphatic beds appear massive and structureless.

Samples and methods

Representative samples from different phosphatic deposits were prepared as thin sections and examined under the optical

Download English Version:

<https://daneshyari.com/en/article/4739250>

Download Persian Version:

<https://daneshyari.com/article/4739250>

[Daneshyari.com](https://daneshyari.com)