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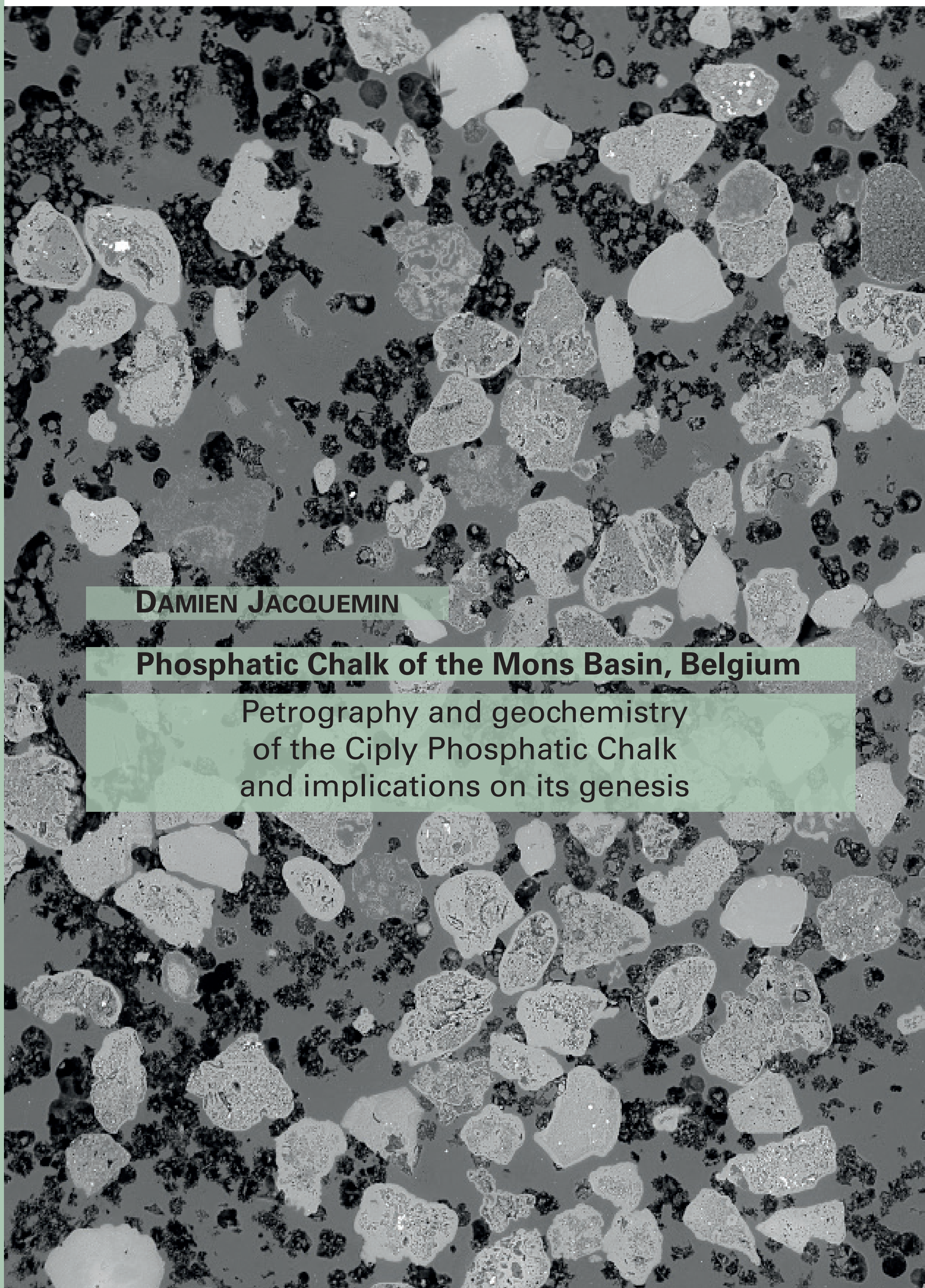

DAMIEN JACQUEMIN

Phosphatic Chalk of the Mons Basin, Belgium

Petrography and geochemistry
of the Ciply Phosphatic Chalk
and implications on its genesis

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PHOSPHATIC CHALK OF THE MONS BASIN, BELGIUM

PETROGRAPHY AND GEOCHEMISTRY OF THE CIPLY PHOSPHATIC CHALK AND IMPLICATIONS ON ITS GENESIS

by Damien JACQUEMIN

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Abstract

The Ciply Phosphatic Chalk (CPC) has been exploited for its enrichment in phosphorus in the early part of the twentieth century to produce fertilisers. Regained interests stimulated new research to characterise the potential for rare earth elements (REE) endowment and propose a genetic model for the formation of this phosphate deposit. This work studied the CPC using scanning electron microscopy, X-ray diffraction, cathodoluminescence and geochemical analyses. New insights into the formation of the deposits have been obtained regarding the mode of formation of the deposit. These results nicely complement the genetic model already proposed by Poels and Robaszynski (1988). First, the deposit clearly shows evidence of alternating phases of phosphatisation and reworking giving rise to the formation of phosintraclasts, which are the dominant phosphatic grains of the deposit. Weak or moderate upwellings brought nutrients to the Mons Basin during a period of sea-level highstand. Negative Ce anomaly and the presence of bioturbation strongly argue against the development of an important oxygen-minimum zone indicating a low-productivity system. In these conditions, Fe-oxyhydroxides might have played an important role in scavenging phosphorus from the water column to the sediment. Phosphatisation seems to have occurred in the sediment when supersaturation relative to francolite (a carbonate-fluorapatite (CFA) [$Ca_5(PO_4,CO_3)_3F$]) was reached in the sediment pore water. Reworking processes probably consisted of wave action during storms. The REE are hosted in francolite and possess an average ΣREE of 350 ppm for the Hyon borehole. Their shale-normalised patterns are similar to other Cretaceous phosphate deposits but also to Cambrian deposits of China, which typically display negative Ce anomaly and HREE depletion. Post-depositional processes are only evident for the phosphatic sands in cryptokarsts, which are strongly enriched in both phosphorus and REE. Further studies should aim to better constrain the paleoenvironmental conditions of deposition using stable isotopic studies. LA-ICP-MS studies should be able to give interesting insights into the compositional variations of the phosintraclasts thus giving elements to better characterise the genetic model of the CPC.

Keywords: phosphatic chalk, phosphogenesis, Upper Cretaceous, phosphate deposit, REE potential

1. Introduction

The Ciply Phosphatic Chalk of the Mons area (southwest Belgium) was a significant source of phosphate for Belgium in the 20th century. The exploitation took place from the end of the 19th century until World War II. The "phosphatic sands" – with grades attaining 30-35% P_2O_5 – were the first parts of the deposit to be used. They resulted from a weathering process of weak intensity (De Putter *et al.*, 1999). Then, the phosphatic chalk with 8-10% P_2O_5 was extracted in underground galleries and open quarries. Between 1880 and 1945, more than three million tons were mined from the entire phosphatic basin.

The phosphatic basin has an area of about 23 km². The phosphatic chalk generally exceeds 20 m in thickness and in some places attains 76 m. Resources were evaluated at 960 million tons of phosphatic chalk at a grade comprised between 5 and 10% P_2O_5. Out of those resources, 20 to 30 million tons with an average grade of 5-8% P_2O_5 were considered as a seemingly easy workable area (Robaszynski & Martin, 1988).

Phosphorus, rare earth elements (REE), phosphate rocks and 24 other materials are considered critical

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The phosphatic calcarenite of the Mons Basin was formed under the influence of minor upwelling systems that brought nutrients, such as phosphorus and silicon, to the shallow epicontinental sea of the Mons Basin during transgressive/regressive events. The formation of the phosphate is linked to an overall period of eustatic sea-level highstand, with reworking during subsequent regressive conditions. The Ciply Phosphatic Chalk of the Mons Basin may represent a cycle of transgression-regression where nutrients are brought as the sea-level rises. The hardground capping the sequence originates from the following regression, which prevented sediment deposition. Since the overlying Tuffeau of Saint-Symphorien is a coarse calcarenite, poor but not devoid of phosphates, indicative of shallow environment, the hardground could only represent the optimum or the end of the regression stage.

Phosphogenesis occurred in the sediment mostly in the form of peloids and interparticle carbonate-fluorapatite cement (CFA). Microbial breakdown of organic matter along with Fe-redox cycling are the processes of phosphorus pore water enrichment. There is no direct evidence of microbial phosphatisation.

The primary phosphatic sediment was reworked in the form of phosintraclasts. Several phosphatisation and reworking events took place. The rare earth elements were incorporated in CFA during phosphogenesis. The ultimate source of REE in phosphorites is seawater and the REE patterns recorded in the phosphatic chalk should retain to some extent the primary signature of seawater. However, the original seawater signature was altered by syndepositional processes.

The Ciply Phosphatic Chalk represents a non-negligible source of phosphorus and REE for Europe. However, the direct proximity of urban areas renders further exploitation of the deposit very difficult.

Further studies should aim at better characterising the paleoenvironmental conditions (pore-water temperature, age of phosphogenesis…).

The author of this monography is a young geologist (Ma in Geology from the Oulu University, Finland). The present work corresponds to his research activity under the supervision of Dr Sophie Decrée (RBINS) and Prof. Jean-Marc Baele (UMons).

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