CHEMISTRY RESEARCH AND APPLICATIONS

Biogeochemistry of Trace Elements

Oleg S. Pokrovsky
Jerome Viers
Editors

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BIOGEOCHEMISTRY OF TRACE ELEMENTS

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Chapter 2

LITHOLOGICAL DISTRIBUTION OF RARE EARTH ELEMENTS IN SOIL AND ATMOSPHERIC PRECIPITATES IN THE BREGALNICA RIVER BASIN

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ABSTRACT

The present chapter gives an overview of the rare earth elements **(**REEs) distribution in automorphic and alluvial soil (top and sub-soil samples) and moss species in the environs of Bregalnica river. There are 17 rare earth metals (REMs) or rare earth elements (REEs), comprising the elements La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Sc and Y. Fifteen of the REMs constitute a group of elements called lanthanides and are found between the atomic numbers 51 and 71 in the periodic table of elements. Beginning with the atomic number 51, the lanthanides include the following elements: La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu. These elements are grouped together because they exhibit similar chemical and physical properties, considered as REEs. REEs possess certain unique but identical physical and chemical properties which make them useful markers of specific geochemical reactions in soil REEs can be accumulated in different areas of the environment following

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anthropogenic inputs because of the low mobility of these elements. The present investigation presents the first attempt to characterize the REE distribution in soils and moss species in the Bregalnica river basin in the eastern part of the territory of the Republic of Macedonia. The geochemical interaction of these elements plays an important role in the lithological distribution of mineral elements. The element contents were determined using inductively coupled plasma with mass spectrometry. The content of the light rare earth elements (LREEs) in the whole investigated area ranges from 8.6 to 225 mg kg^{-1}, while the content of the heavy rare earth elements (HREEs) ranges from 0.92 to 33.7 mg kg^{-1}. The distribution of the LREEs (La, Ce, Pr, Nd, Pm, Sm, Eu and Gd) is predominantly related to the Quaternary terraces and the Paleogene flysch. The anthropogenic activities that occur in the Pb-Zn surroundings and the Cu mineralization in the investigated area significantly influence the lithological distribution of this geochemical association of elements. On the other hand, the distribution of the HREEs (Tb, Dy, Ho, Er, Th, Yb and Lu) presents a typical geochemical association in the area of the Bregalnica river basin.

INTRODUCTION

There are 17 rare earth metals (REMs) or rare earth elements (REEs), comprising the elements La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Sc and Y. Fifteen of the REMs constitute a group of elements called lanthanides and are found between the atomic numbers 51 and 71 in the periodic table of elements. Beginning with the atomic number 51, the lanthanides include the following elements: La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu. These elements are grouped together because they exhibit similar chemical and physical properties, considered as REEs. REEs possess certain unique but identical physical and chemical properties which make them useful markers of specific geochemical reactions in soil (Cao et al., 2000, 2001). REEs can be accumulated in different areas of the environment following anthropogenic inputs because of the low mobility of these elements (Zhang et al., 2001; Laveuf et al., 2008). The most plentiful REEs, cerium and yttrium, occur more often in the Earth's crust than lead, molybdenum, or arsenic. Lanthanum and neodymium occur in similar quantities to lead (Holden, 2001), but even thulium, the rarest of the rare earth elements, can be found more often than gold, platinum, or iodine (Brown et al., 1990). Approximate values of REE contents are usually in the range of 150 mg kg^{-1}. Promethium, however, has been found only in very small amounts in uranium ore deposits (Riondato et al., 2001).

Under natural conditions, lanthanides exist as oxides, silicates, carbonates, phosphates, and halogen compounds in minerals (Tyler 2004). The amounts of individual REEs found in different mineral sources vary, yet the similarity in their ionic radius, oxidation state, and general properties results in their universal occurrence in all rare earth minerals. Therefore, not a single known mineral contains only one lanthanide as its major constituent. However, the establishment of the typical lanthanide contents in minerals allows their origins to be determined. This is also used for geochemical research on rock formations (Möller, 1963).