



Contamination of the Xiropotamos stream sediments (Drama district, Western Rhodopes massif, Northern Greece) by mining and mineral processing activities

Замърсяване на речните седименти на Ксиропотамос (област Драма, Западнородопски масив, Северна Гърция) от минна и металургична дейност

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Абстракт. Районът на град Драма е бил център за производство на манганови руди, от пререботката на които във фабриките на Като Неврокопи са останали големи количества рудни отпадъци. Изследвано е замърсяването с тежки метали на седиментите на Ксиропотамос, която преминава през минния район. Установи се, че концентрацията на токсичните метали Mn, Zn, Pb и Cu в седиментите е изключително висока и надвишава допустимите граници. Причина за това са мангановите минерали с високо съдържание на тези метали, които се пренасят при процеса на изветрянето в седиментите на Ксиропотамос.

Key words: Drama, contamination, heavy metals, mining activities

Heavy metals are a notable source of pollution both in the aquatic and soil environments. Although many heavy metals are necessary in small amounts for biological viability, most become toxic at high concentration and may constitute long-term health risk to ecosystem and humans (Samsoe-Peterson et al., 2002). Determination of the concentration of these elements in the polluted environment is important in assessing of their potential environmental impact. The introduction and concentration of heavy metals into soil and sediments has been the subject of increasing study in recent decades (Alloway, 1990; Forstner, 1995). Mining, mineral processing or smelting activities and waste disposals constitute the major anthropogenic sources of heavy metals in environment.

Drama region is one of the most extensively mined areas in Greece with more than 7 Mt total concentrate production of Mn-oxide of battery-type (Nimfopoulos et al., 1997). The study area geologically belongs to the western part of the Rhodopes massif, which comprises marbles, and a sequence of alternating gneisses, mica schist, amphibolites and marbles. The Mn-mineralization is confined to fault or thrust zones and contains supergene ores predominantly composed of Mn-oxides (Michailidis et al., 1997). Mineral processing created a vast amount of

wastes including tailing and low grade ore which were deposited around the central mining establishment of Kato Nevrokopi. Some years ago the mining activity in Drama region stopped, we hope not definitely. These wastes are easily transported by fluvial processes towards the alluvial plains.

The present research examines the prospective contamination of the Xiropotamos stream sediments by heavy metals. The Xiropotamos stream passes through the Kato Nevrokopi mining area and terminates to the Angitis River. A total of twelve sampling sites were chosen along the course of the stream starting from the Kato Nevrokopi up to the Angitis River.

X-ray diffraction and microscope studies of the stream sediments showed that the prevailing gangue minerals are quartz, calcite, mica, and feldspars. The mineral composition of the sediments was found comparable to the mineralogy of the rocks hosting the Mn-mineralization.

Chemical analyses for major, trace elements and heavy metals assessed on bulk sediment samples by atomic absorption spectroscopy showed that the Xiropotamos stream sediments are heavily contaminated by some toxic elements. Average metal concentrations (and variations in parenthesis) were

found as follow (in ppm): Mn = 131863 (70333–197368), Zn = 3302 (1151–5180), Pb = 1612 (430–3046), Ba = 542 (331–740), Cu = 158 (50–308), Sr = 99 (461–1151) and Ni = 74 (68–1020). These values are significantly high exceeding the maximum accepted concentrations for soils (Kloke, 1980; Ewers, 1988) and the directives of Greek and European legislation. The concentration of Mn, Cu, Pb, Zn, and Ni exceed the maximum phytotoxic levels quoted by Kabata-Pendias and Pendias (2001).

Electron microprobe analyses and SEM studies revealed the presence of the manganese minerals todorokite, pyrolusite, birnessite, and coronadite in the streams sediments. The Mn-minerals were found containing variable amounts of the above toxic ele-

ments. Maximum concentrations of metals were (in wt.%): PbO = 33.34, ZnO = 14.61, CuO = 1.99, BaO = 0.72, SrO = 0.66, and Ni = 0.28. These results suggest that the prime cause of sediments contamination must be the manganese minerals induced to the stream sediments by the run-off of mining and processing wastes of Kato Nevrokopi.

Hence, the contamination of the studied sediments is high and very widespread, with metal contents exceeding the safety limits established. For this reason some protective measurements have to be taken in order to stop the transportation of manganese-ore wastes from the disused establishment, through the Xiropotamos stream, to the Angitis River and the surrounding plain.

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