AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

Geo-Ecological Problems of Kursk Magnetic Anomaly in the Russian Federation, Ways And Means for Their Remedy

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ARTICLE INFO

Article history:
Received 25 April 2014
Received in revised form
8 May 2014
Accepted 20 July 2014
Available online 18 August 2014

Keywords:
geo-ecological problems, Kursk magnetic anomaly, monitoring, sustainable use of natural resources, reclamation.

ABSTRACT

This Article is dedicated to analysis of modern geo-ecological problems of Kursk magnetic anomaly (KMA) that takes place as a result of mining enterprises' activities. The system of constant complex monitoring of natural and engineering systems has been developed, which suggests using new methods of environmental optimizations. Based on the expertise in reclamation of spoil heaps in KMA, the most effective remedies for region's geo-ecological problems were marked.

To Cite This Article: Alexander Nikolayevich Petin, Valeriy Konstantinovich Tokhtar, Valentina Ivanovna Petina., Geo-Ecological Problems of Kursk Magnetic Anomaly in the Russian Federation, Ways And Means for Their Remedy. ***Adv. Environ. Biol., 8(13),*** *20-22, 2014*

INTRODUCTION

KMA Iron-ore province is located in old-cultivated of Central Black Earth economic region of European part of the Russian Federation. According to ore reserves and their quality KMA basin tops the universal list, and in terms of ore production it occupies the first place over the Russian Federation. However, widespread commercial development of iron ore raw materials led to complex environmental situation in KMA region [1, 2].

Continuing degradation of environmental quality in mining districts of KMA urges finding ways and methods of overcoming negative consequences of human intervention to natural systems' functioning, including ecological and geological systems [3]. In this respect the development and implementation of ecologically balanced approach to development of region's mineral resources seems to be an urge need.

Methods:

For meeting the objectives we had set we used various study methods: system-analysis one, landscape and geological one, the method of GIS technologies, method of retrospective analysis, remote sounding of land surface, multivariate statistics, state estimation of vegetation mantle per hemerobia indices etc.

Main part:

We consider complex geo-ecological and botanic monitoring to be an important and necessary instrument for implementing mechanisms of provision of geo-ecological safety of KMA iron-ore deposits' development.

Based on the expertise of KMA spoil heap study we developed structural scheme of complex monitoring of natural and technical systems of KMA mining areas, which may be presented schematically (Picture 1). While creating monitoring system for mining area, besides aboveground, belowground and aerologic measuring, it would be very effective to create means and methods of space-air sensing of the Earth's surface. Among the variety of GIS technologies, image processing system ERDFS (ERDAS Ine) meets the abovementioned requirements, which is extremely important for space data processing. Together with vector-format systems (e.g., ESRI company's ARC/INFO systems) ERDFS system may become GIS basis for geo-ecological systems of mining region's monitoring.

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Within the framework of scientific and technical level of extraction and processing of commercial minerals, besides for traditional measures for reduction of man-caused load of mining production on the environment, it is necessary to use areal dust suppression technologies, ground waters' protection, new technologies of hydraulic mining by boreholes and other technologies, confirmed by patents, more intensively

Considering inhomogeneity and tessellation of ecotopes that form in these condition, an important instrument for solving these geo-ecological problems

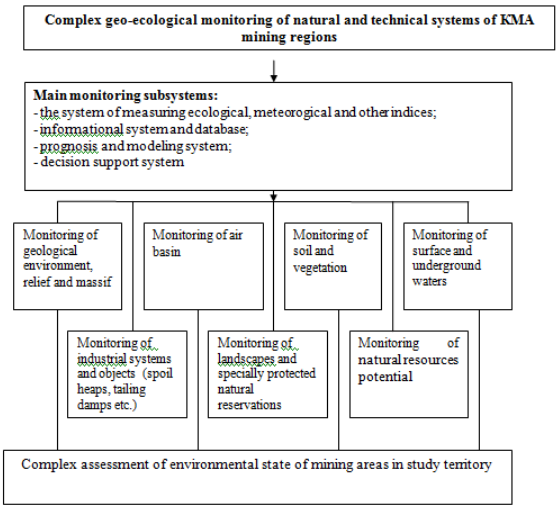

Fig. 1: KMA Structural scheme of complex monitoring of KMA mining regions.

is an express assessment of the state of vegetation mantle, which is forming in the radius of ore mining spoil heaps, as well as the development of effective methods of industrial ecotopes' phytoremediation. We have stated that one of the most advantageous means of preliminary assessment of manly-transformed ecotopes' state for the development of project for their ecological remediation would be a complex of methods that use GIS technologies (pixilated three-dimensional evaluation of mosaic vegetation mantle of spoil heaps), hemerobia indices and methods of multivariate statistics [4, 5, 6].

As a result of studies of KMA ore mining spoil heaps, we singled out various ecotopes: 1. Areas with newly formed surface soil, characterized by initial stage of vegetation mantle's formation, 2. Areas with fully formed surface soil, where mainly perennial plants are growing, and where tree vegetation is absent, 3. Areas with fully formed surface soil, covered with plant aggregations of perennial plants and trees.

One of the most important means of solving geo-ecological problems is provision of work package for phytoremediation of plants depending on previously stated characteristics of spoil heaps' substrates and known ecological and biological characteristics of the species. The usage of such empirical approaches allows selecting the species that fit best for growing in specific environmental conditions, to make phytoremediation processes significantly cheaper, to suggest different variants of plants' combinations for growing on mosaic areas of spoil heaps, considering the degree of man-induced transformation, substrates' characteristics and ecotopes' microclimatic peculiarities.

Both we and a number of investigators at other objects [7] stated that at the objects of mine rock areas with small presence of sand, clay and residues of black soil man-induced ecotopes successfully overgrow, unlike the ecotopes that are formed with the only one massive rock. Cretaceous and chalk-marlacious areas seem to be the ones with the least tendency to overgrowth. That's why slope dressing with a thin bed (5-10 cm) of loamy or sandy soils is the cheapest and the most effective means of phytoremediation. As a result of these activities' provision mixed substrates are formed, which are much more adaptable for overgrowing by the plants. These measures allow substantially speeding up syngenetic processes that occur in these conditions. However, such method would be a prospective one only for the usage in local conditions of specific territories, whilst requiring control of possible occurrence and spontaneous disseminations of adventive and even quarantine species of plants in these conditions.

We took bioindicational scales of G. Ellenberg [8] and T. Landolt [9] as the basis for assessment of species' ecological characteristics. An important criterion for selection of species is correlation of plants with main factors of soil's humidity and acidity, illumination and shadowing, which limit their growth and development. Other important factors are soil's abundance in elements of mineral nutrition and content of humus and various mechanical content of the soil, its winter hardiness.

We performed investigations that allowed us to suggest 155 advantageous types of woody plants of various geographical origin, which may be successfully used for creation of stable plant associations on spoil heaps and

open pits that are forming in the course of mining and concentration complexes on the territories of the region in question.

Summary:

The concept of complex active geo-ecological and botanic monitoring of mining companies was developed and implemented. The system of such monitoring is considered as normative and methodological base for managing natural and technical system's state. The system allows controlling geo-ecological situation of the territory that is being developed, and to minimize ecological and technical risks while in the course of development of KMA iron ore raw materials.

Conclusion:

Summing up, in the course of our investigations we stated that effective system of complex active geo-ecological and botanic monitoring of ore mining spoil heaps presupposes performance of stepwise activities on assessment and optimization of man-induced medium. Its functioning draws upon the usage of brand new contemporary means of investigation, among which the following ones can be emphasized as being the most important ones: special technologies of areal dust suppression, protection of underground waters from pollutions, new technologies of hydraulic borehole mining of high-grade iron ores and other technologies, confirmed by patents, complex of methods that uses GIS technologies (pixilated three-dimensional evaluation of mosaic vegetation mantle of spoil heaps), empirical selection of plants, characterized by man-impact tolerance, multivariate statistics, which help visualize the differences in vegetation mantle's formation, as well as to isolate statistical factors that limit its development.

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