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Applying intelligent management comprehensive system in rental estimation of Russian rare-earth deposits of global resource cluster

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Abstract

The assessment of Russian rare-earth deposits of global resource cluster was carried out. The possibility to use the expected rental income as an indicator to evaluate preference and economic value of the developed deposit from the perspective of annuity payments which should be made to a deposit owner when carrying out future production activity was investigated. It is demonstrated that application of the known mathematical method to select sustainable solutions at the different stages of marketable products designing, engineering and production process development allows to reduce costs while achieving strategic goals of crating and developing Russian rare-earth industry.

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Keywords: rare-earth elements ; deposits ; rare-earth metals

1. Main text

Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 10 pt. Here follows further instructions for authors.

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An increase in demand for rare-earth metals (REM) is conditioned by active development of industries that are the ultimate consumers of these products. It is known that about 20-30% of REM ultimate consumption falls on the state-controlled defense and space industries, where rare-earth elements are used as a part of constructional materials, optical and electronic engineering. Price leaps at the global market over the last several years, increasing demand for the specified products in high-technology industries and export delivery monopolization by Chinese REM manufacturers led by their 4-7% deficit at the market. As predicted, this deficit will remain unchanged in the coming 2-3 years, and, according to preliminary assessment of the global market conditions (Table 1, [1,2,3]), in case of certain elements it can become significant and even critical.

Table 1. Matrix of price increase and REM demand satisfaction risks till 2015

PRICE INCREASE RISK	ELEMENTS			
Critical			Y	Dy, Tb
High	Gd, Ho	Er		Eu
Average		Sm	Nd	
Low	Yb	Pr, La, Ce		
Risk levels	*Low*	*Average*	*High*	*Critical*
	DEMAND SATISFACTION RISK			

Mineral resources base of the current rare-earth business is rather diverse and heterogeneous in its mineral composition and geographical location. Different types of mineral raw materials are divided into primary (natural) and secondary (man-made) sources, and deposits of these elements are characterized by complex mineralogical content. Furthermore, every deposit contains a lot of economically exploitable metals with similar properties. Their selective development in the form of oxide or metal is restricted or even technically impossible and that is why, under industrial conditions, components, containing most or even all elements, are extracted from them, and after that they are separated into the ultimate concentrate, from which specific metals are recovered. Many technologies for oxides and high- or even ultra-purity metals are critical which is proven by the importance of their following application in various productions and products of both civil and military nature.

It is common knowledge that rare-earth metals are widely spread in the Earth crust; however, its natural concentration in ores is not too large. For this reason, just a small number of deposits is viable enough to be developed given the current technology state-of-the-art. The main industrial sources of rare earths are such minerals as bastnasite, monazite, loparite and ion-absorptive clays. Bastnasite and monazite-bastnasite ores account for over 80% of all known REM reserves. More than a half of REM reserves is contained in bastnasite deposits of China and the USA, monazite deposits are spread in Australia, Brazil, PRC, India, Malaysia, RSA, Sri-Lanka, Thailand, loparite deposits are located in Russia. The rest of REM resources are grouped with deposits of xenotime, ion-absorptive clays, phosphorites, apatites, eudialytes etc. Overall REM reserves by countries is shown in Fig. 1 [4,5].

As reported by the British Geology Survey, global mineral raw material base of REM is represented by fifty three deposits. Major producing ones are situated on the territory of the People's Republic of China (including the largest deposit in the world – Bayan Obo), the United States of America (processing is executed by Molycorp Corp. on the base of ore concentrate warehouse stock at the Mountain Pass deposit), the Russian Federation (REM mining is made at the Lovozero deposit) and India (REMs are taken from the off-shore placers). In 2011, by USGS estimate, total world REM reserves and resources were 113.8 mln tn, which, according to the data from different experts, allows providing global manufacture of REM products equivalent to oxides at the level of up to 135 thousand tons per year[6]. Russia is ranked number two in its volume and reserves of REM. National register of the Russian Federation recorded sixteen REM deposits[7]. Significant REM deposits allow considering Russian mineral raw material base as a promising direction for development of long-term projects in the field of REM complex mining and processing. In terms of inferred resources and grade of REM concentration, Russian deposits (Lovozero,