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EMILIAN M. DOBRESCU[1]

The progress of ideas

GENERAL CHARACTERIZATION OF RARE EARTH ELEMENTS

Abstract

For the first time in economics use this phrase - "rare earth economy" as a discipline border, which is holding up the subject of the Economy as General Science, to the subject of this new frontier scientific disciplines - economics RARE EARTH - studying production, distribution, circulation and consumption of earth rare. This border is a science derived from Economics, whose object of study is rare earth production and use economy.

On the Planet, over a quarter of new production technologies using rare earth economic goods, which are also called critical minerals and industries that rely on precious items worth an estimated nearly 5 trillion dollars, or 5 percent of world GDP. In the near future, competition will increase and local economic competition for control of rare earth minerals embedded in high-tech products. Rare minerals are in the twenty-first century what oil accounted for the twentieth century and coal XIX century: the engine of a new industrial revolution.

In the periodic table, created by Russian scientist Mendeleev, you can see the position of rare earth - they occupy places from 57 to 71 of Table. Rare earth metals are a group of similar properties that include scandium (21Sc), yttrium (39Y) and 15 lanthanides, all chemicals are not rare, but highly reactive.

Key words: *critical metals, permanent magnets, rare earth, rare minerals, rare earth deposits, rare earth economy.*

1. Introduction

Future energy is produced increasingly more technological equipment based not just steel and concrete, but incorporates significant quantities of metals and rare earths. Widespread application of these technologies will result in an exponential increase in demand for such minerals, and what is worrying is that minerals of this type are almost nowhere to be found in Europe and other industrialized countries in the world, such as U.S. or Japan. Becoming increasingly used in new technologies, especially negative effects on the environment, mainly rare earths are produced in China. Obtained by highly polluting, these metals are difficult to extract from containing it is.

Rare earths are a new concept, which will be known as more will invade our daily life. In 1982 there were still only a very little known makers of intelligence and policy areas (see, to that effect, once again, the motto of our work, from Deng Xiaoping). Technological applications, military and increasingly more civil, which are necessary abound from the TV stones lighter colors, through advanced electronics and weapons "intelligent" (see Annex Nr. 1).

All sectors of the art uses "permanent magnets" or other components that call for rare earths. The importance of these raw materials is obvious. On the other hand, to complicate matters, China has become the last 5 years almost the only producer of rare earths in the world given that many tens of tons of metal annually, all "rare" derivative technologies are required peak current applied on Earth.

E.U., U.S. and Japan, and increasingly more and emerging countries such as the BRIC (Brazil, Russia, India and China) depend on their supply of these rare metals, even strategic. Rare earths are therefore of materials called "critical" for economic and military fields. Identified in the eighteenth century, they are not at all "rare" in the proper sense of the

[1] Romanian Academy , e-mail: dobrescu@acad.ro

word. Clearly, some rare earths are available in larger quantities than copper, gold, lead or platinum.

Only a very limited number of the concentrations of rare earth ores, industrial exploitable, often associated with other minerals (such as iron). World production of rare earth - about 150,000 tons per year is relatively modest compared to the 2.3 billion tons of iron produced annually[2]. Electronic or industry sectors "green", these minerals "critical" are really indispensable.

Rare earths are considered long fifth strategic feedstock, after water, steel, oil and rubber. Many of the strategic battles of World War II took place for control of future oil supply (in Eurasia) and rubber (in Southeast Asia).Series of so-called local wars, fought in the last three or four decades in Afghanistan, Iraq and Iran took place also for oil and rare earths, as apparent from the contents of this paper.

2. Important metals in rare earth composition on Earth

Is quite difficult to find pure rare metal oxides or concentrated. Class lanthanides listing these elements of the periodic table of elements, Mendeleev made a sound like a recitation from Latin: Lantaniu, cerium, praseodimiu, neodymium, prometium, samarium, europium, gadolinium, terbium, Dysprosium, holmium, thuliu, erbium, yterbiu and luteţiu. Actinides and lanthanides, as listed in Mendeleev's periodic table of elements together are called "rare earths". The term "rare earth" refers to minerals that are vital first isolated metals: Cerium, Dysprosium, Lanthanum and neodiu. The rare earth experts understand today the 17 items used increasingly more in today's economy in a wide variety of industrial technology applications. (See 4.3 of the paper).Rare earths were discovered by a Swedish army lieutenant in 1787. Most of the elements of the two classes, lanthanides and actinides, are quite common: most of them are more abundant in Earth's crust than lead or gold, for example.

Rare earths deposits are, preferably, with the precious metal. For a long time this was noted in the U.S. State of North Carolina, gold washing processes, resulting brownish yellow sand, with a high density, which is mineral called monazite.[3].

Most use magnets that are in composition are neodiul rare earth (NdFeB) and Samaria-cobalt (SmCo). Magnets based on rare earths - like neodymium-iron-boron or samarium-cobalt permanent magnets are the most technically advanced. Net benefit of NdFeB magnet type is given by the size and low weight, high reliability and excellent magnetic characteristics. Surface type NdFeB magnets can protect zinc, nickel or regular paint. Magnets of this type must be protected surface, otherwise corrode.

Applications made at higher temperatures is recommended samarium-cobalt magnets that are very stable. Due to component materials, this type of magnet does not corrode, successfully resists the harmful effect of acidic or basic liquids.

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[2] cifre oferite de US Geological Survey, 2011

[3] Paul Truchot, *Les terres rares: mineralogie, proprietes, analyse*, Paris, G. Carre şi C. Naud, 1898, p. 29. Lucrarea prezintă începând cu pag. 275 bibliografia metodelor de separare şi fracţionare a oxizilor rari

The 30 elements called rare earths, which part of Lanthanide series and Actinide series

Lanthanides series	Actinide series
• Lantaniu	Actinium
• Cerium	Thorium
• Praseodimiu	Protactiniu
• Neodymium	Uranium
• Promethium	Neptunium
• Samarium	Plutonium
• Europium	Americium
• Gadolinium	Curium
• Terbium	Berkeliu
• Dysprosium	Californiu
• Holmium	Einsteiniu
• Erbium	Fermiu
• Thuliu	Mendeleeviu
• Yterbiu	Nobeliu
• Luteţiu	Lawrenciu

Rare earths are elements belonging especially lanthanides group. REE like Samaria and Cesium can form with cobalt, ferromagnetic compounds with good magnetic properties. Magnets of these compounds can be made by molding, cold pressing or sintering. Magnetic energies obtained with magnets made of rare earth compounds are the biggest of its kind known to date.

From an economic perspective, rare earths are part of strategic metals. Metals or rare earths are, contrary to what their name suggests, equally distributed in the earth's crust as usual metals, for example, wax is as common as copper, while thuliul is less prevalent. Rare earths are in high demand in recent decades in the composition of products and high-tech industries.

Elemental form, rare earths are metallic look soft, malleable and ductile as. These elements are chemically reactive, especially at high temperatures or when finely divided. Their name comes from the fact that they were discovered in the early nineteenth century in minerals - hence the name "earth", name used at that time in French, international language for oxides, the name is less common today, the commercial exploitation of these minerals is scattered over the entire surface of the Earth may be difficult to separate from each other: *rare earths* means so *rare minerals*. Given their geochemical properties, they are very unevenly distributed in the earth's surface, often in concentrations that are less economically viable mining exploitation.

In class lanthanides enter lantaniul and 14 chemical elements that are periodic classification table of elements with atomic numbers from 57 to 71[4]. Table of lanthanides are classified Mendelelev with actinide series (see the second column of the table above).

Swedish chemist Jacob Berzelius Jöns (1779-1848) first lanthanides separated into two sub-groups according to their solubility sulphates: a) cerium group comprising lantaniul, wax praseodimiul, neodimiul, Prometheus and Samaria (elements with atomic number Z of the 57-63 or land Ceric) and b) yttrium sub-group comprising the Euromarket, gadolinium, terbiul, dysprosiul, holmiul, herbicides, thuliul, yterbiul and luteţiul (elements with atomic number Z from 64 to 71, also known as lands ytrice).

[4] * * *, *Lanthanides et terres rares,* pe site-ul www.larousse.fr/encycopedie, vizitat pe 20 iulie 2012, orele 21,28

Another sub-group of rare earth consists of scandium and yttrium, which have comparable electronic forms, the similarities with lanthanides and therefore are often studied together.

Despite the late discovery and the difficulty of separating them, the rare earths are significantly present in the earth's crust: the world's reserves are estimated at 45 megatons [5]. Of rare earths, lantaniul and neodiul are more abundant in nature in comparison with lead, for example, and Cerium is more prevalent than tin or zinc. Few experts know that the two substances of Class landatine - thuliu and luteţiu - are nearly 200 times more common in the earth's crust than gold, according to findings based on satellite exploration conducted by the U.S. Geological Survey.

Rare earths no individual state or crust, but only in about 150 mineral mixture known and inventoried, with specific distributions for each.

Rare earths same external electronic configuration and, following this, have similar chemical properties. Lanthanides differ only by internal electronic structure of a layer, the so called internal transition elements. This feature explains their group that have similar physical and chemical properties. Their great affinity for oxygen translates into a significant pirofosforicity metal of composition, as through a chemical bond stability of rare earth/oxygen. Rare earths easily combine with anions to give salts, soluble (chloride, nitrate) or insoluble (sulfides, fluorides, carbonates, oxalates, phosphates) may be set off in a large number of synthetic mineral compounds (borates, molybdates, silicates), bound in two or more distinct layers by organic molecules to form very stable complexes.

We must distinguish between rare earths and rare metals. These are two distinct categories of substances, even if the first one generates the second. To avoid confusion, experts speak of "critical metals". Rare earths are not pure in nature, only in exceptional cases, while "critical metals" bearing each a name clearly expressed.

In July 2010, an expert committee under EU has classified the 14 "critical metals", separated by various technologies of the rare earths, essential for the manufacture of new products (see Chap. 4 of the work). The rate of 97 percent, these "critical metals" were exported from China between 2006-2011, is now less recyclable, so no substitution solution.

Two minerals are essential global reserves of rare earths: 1. bastnasita (composed of cesium, lantanium and yterbium, that are part of an iron oxide) which is found mainly in China and the U.S., 2. monazite, which is found mainly in Australia, Brazil, China, India, Malaysia, South Africa, Sri Lanka, Thailand and the U.S. can exploit mineral by chemical composition in 4 varieties: a) monazite cesium; b) monazite with lantanium; c) monazite with neodium; d) monazite with praseodium.

Other exploitable minerals containing rare earths are:

- apatite CA5 (PO4) 3 (F, Cl, OH);
- cheralita (Ca, Ce) (Th, Ce) (PO4) 2,
- eudialyta (Na15Ca6 (Fe, Mn) 3Zr3SiO (O, OH, H2O) 3 (Si3O9) 2 (Si9O272 (OH, Cl) 2,
- lopar (Ce, Na, Ca) (Ti, Nb) O3,
- fosforiţii 3Ca3 (PO4) 2 • Ca (OH, F, Cl) 2,
- rare earth clays (exploitable by ionic adsorption method);
- secondary monazite;
- uranium waste solutions;
- xenotimul.

Minerals containing rare earths are in fact composed of many metals. Before the 50s, not known separation processes of various metals and rare earths, which had only a limited use. Thanks to current technology, now at the beginning of the twenty-first century can separate

[5] US Geological Survey, 2011 (selectiv)

each of the rare earths, which can be used to obtain consumer economic goods (eg batteries for hybrid cars or mobile phones). Therefore, plants based on lithium car batteries are in search of new sources of lithium, a key ingredient for next-generation car batteries and performance.

3. Importance of "critical metals" for the world economy

In 2008, as part of a study group, chaired by Professor Roderick Egert of the Colorado School of Mines and following seminars attended by renowned experts in the U.S., has been developed by the National Research Council of the National Academies, a report entitled "minerals, critical minerals and the U.S. economy." This document brings together the principal recommendations made by the U.S. government regarding the measures that should be taken to secure access to certain non-energy mineral resources considered following scientific assessments, to be critical or strategic to the U.S. economy. Are taking into account all risk factors: availability of minerals that can be extracted by current techniques, degree of substitution, political risks in international trade and strategic materials critical aspects of U.S. defense policy and strategic role that some minerals have when it comes to production technology for civil applications but especially military.

The document, developed in the U.S. was taken as reference and the other reporters and institutions. The European Commission, in turn, efforts to shape a sustainable and integrated strategies for raw materials. To this end the Commission has proposed to assess progress every two years, so that it is possible to identify gaps and correcting measures prove to be ineffective[6].

When they were discovered in the nineteenth century in Sweden, rare earths were considered some of the special features on Earth. Rare earths are relatively abundant in the Earth's basement. However, the extremely high costs of extraction and processing, plus product ecological disaster operations lead to the idea that only areas with rich deposits - very rare - worth exploited. Metals called rare earths are, by their nature, malleable. They also have a high electrical conductivity. Rare earths are extracted from ordinary deposits through a process involving dissolution of elements contained in the ore composite in different liquids - usually water and an acid solvent.

There are, as noted, 17 types of rare earths, each vital to the production of hi-tech, battery-and plasma-screen televisions, computers and mobile phones, nuclear reactors, rockets and seismic monitoring equipment.

Company Toyota, for example, does not have a guaranteed long-term reserves of rare earths for its hybrid car batteries. If the Japanese company wants to ensure future - to produce millions of electric cars, then you should invest in a guaranteed reserve of rare earths. Toyota plants require about 10,000 tons of rare earths per year to manufacture batteries and Prius hybrid model should supply the black market to meet the 2010 and 2011 decisions of the government in Beijing. Already the production of batteries for hybrid cars changing priorities: General Motors has decided to transfer the international operations from Detroit to Shanghai, and Chevrolet factory batteries required for its cars in China, thus respecting the regulation of Chinese prohibiting the export of rare earth. A type of rare earth, terbium, acts as a natural amplifier, therefore, is used for making optical cables, the composition of which amplifies the

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[6] Dumitru Fornea (ex-membru al Comitetului Economic şi Social European, raportor al CESE pentru avizele: “Iniţiativa privind materiile prime” şi “Industria minieră neenergetică din Europa”), din intervenţia sa în cadrul seminarului „Transformarea Europei într-un lider în mineritul responsabil”, Parlamentul European, Bruxelles, 26 ianuarie 2010

signal. Terbium causes change in an electrical circuit when the metal is compressed, therefore, is located in the seismic monitoring devices to detect movement of tectonic plates.

Rare earths are combined in alloys to create strong magnets, used in wind turbines. Magnets are a crucial part of generators that convert natural movement of the propellers into electricity.

Other rare earth, dysprosium is used to manufacture advanced electric motors and battery systems in hybrid vehicles as magnets containing this element can be much lighter and therefore more efficient in terms of energy. Dysprosium has a tendency to absorb neutrons - the tiny particles of atoms produced in nuclear reactions. Therefore, metal components containing Dysprosium is used in nuclear reactors to control the rate of availability of neutrons. Dysprosium magnetic properties of alloys make them useful for manufacture of CD players.

Cerium is used in catalytic converters, which reduce carbon dioxide emissions of vehicles, while creating praseodium yellow ceramic alloys. In alloys, lantanium "smooths" a metal, making it more manageable and sometimes more durable. We can not yet speak about shortages of rare earth deposits, but the risk of not having processed rare earths available for consuming industries.

Fast enough to compensate for the reduction effected Chinese rare earth production, it is essential to make available as fast also invented new deposits on the planet, especially in Afghanistan, but inaccessible deposits because there is infrastructure in the area or discovery of deposits required. But financing such operations is difficult in times of crisis.

Economy of raw materials and manufacturing technologies, some of them, as I mentioned, very recent, does not know and therefore do not allow overnight replacement of these raw materials, rare earth. Obtained permanent magnets based on neodymium have qualities that can not substitutable classic model based ferrites, where the yield is much lower. Only car batteries nickel metal hydride (NiMH) containing lantaniu can be gradually replaced with batteries based on lithium-ion (Li-ion).

ANNEX Nr. 1

OPINIONS ABOUT RARE EARTH ECONOMY

• If mankind will begin to seriously focus on green technology, this could lead to a demand for rare earths, which those who are not able to extract to satisfy.

John Kaiser, California, mining expert for 25 years rare earth industry

• The Japanese are addicted to rare earths. Without them, they can not survive.

Year and Hu, from High Tech Zone Committee for Rare Earths Baotau

• New export quotas are are appropriate and necessary. The reality is that rare earths have so far been sold cheap and random. As Russians enjoy their gas reserves, which supplies much of the European Union, so China currently controls, global reserves of metals and rare earths. However, at least one third of rare earth deposits outside of China there. And the world should operate their own resources. China has already supplied everyone with 90 percent of its rare earths. We have our lands rare for ourselves.

The Chinese government spokesman at a press conference in early March 2010

• This (discovery of important and rare earth ores containing - Ed) will become the backbone of the Afghan economy.

Jumriany Jalil, adviser to the Afghan minister of mines

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