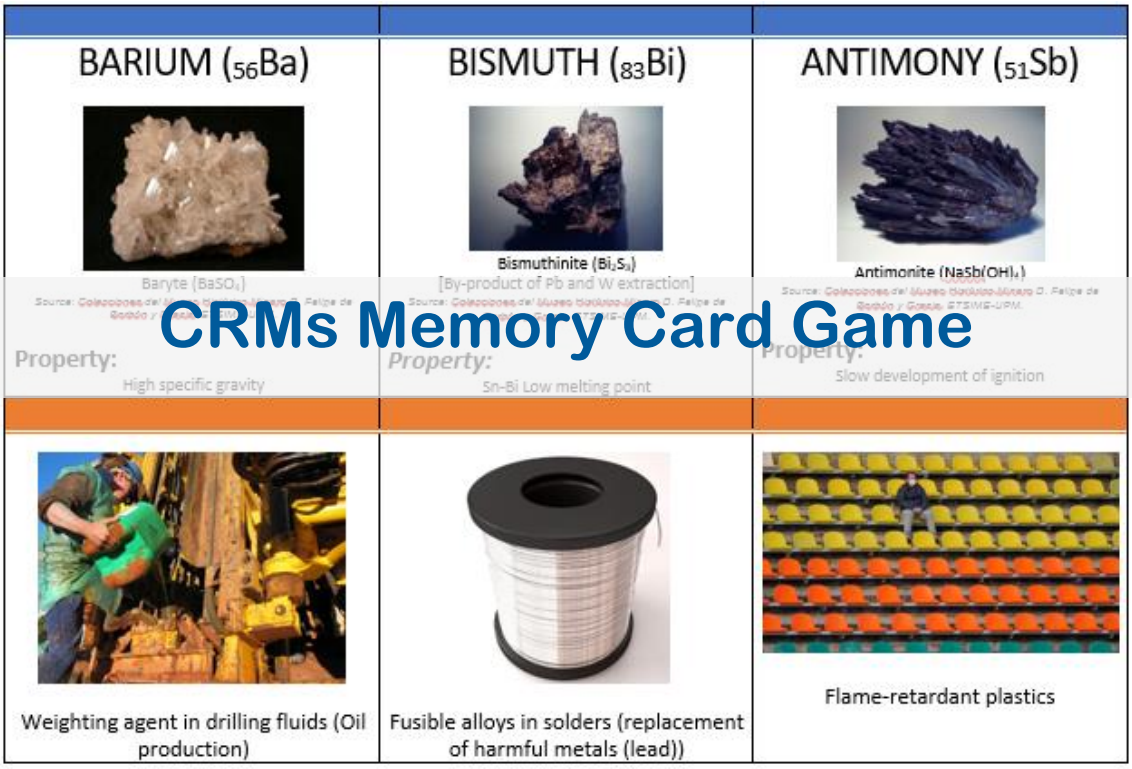
Teachers' Card



CRMs Memory Card Game

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General Introduction

This simple memory card game can be used with a group of students for them to learn, the main properties and uses of several critical raw materials, as well as their importance nowadays in our technological society. They will also be introduced to the current worldwide environmental and socioeconomically concerns.

The targeted audience are students from 15 to 18 years old, as it is advisable that they have some scientific and technological background.

This toolkit is organised in a collection of facts sheets for each Critical Raw Material (CRM) with information on the main mineral/minerals from which are extracted, global supply information, properties and uses. It is completed with a set of cards for students to learn by playing.

Keywords:

CRMs applications, CRMs properties, Minerals, Substitutes.

Extended background information

Critical Raw Materials (CRMs) are those raw materials which are economically and strategically important for the European economy, and also have a high-risk associated with their supply. They are not only 'critical' for key industry sectors and future applications, but also for the sustainable functioning of the European economy. There are three properties that these materials must meet to be considered 'critical':

- **Significant economic importance for key sectors in the European economy:** such as consumer electronics, environmental technologies, automotive, aerospace, military defence, health and steel-making.
- **High supply risk:** very-high import dependence and high level of concentration of set critical raw materials in particular countries.
- **Lack of viable substitutes:** very unique and reliable properties (present and future applications).

To address this challenge, the European Commission has created a list of critical raw materials (CRMs) for the EU, which is subject to a regular review and update at least every 3 years to reflect production, market and technological developments.

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The first analysis for critical raw materials was published in 2011 by the Ad-Hoc Working Group on Defining Critical Raw Materials. Fourteen critical raw materials were identified from a candidate list of forty-one non-energy and non-agricultural materials. Then, in 2014, 44 critical materials were revised and a new list with 20 critical raw materials was set. Afterwards, in 2017, the list was increased to 27 CRMs based on a refined methodology. In January 2018, a report on CRMs including circular economy aspects was published, reviewing relevant EU policies, key initiatives, good practices and indicating possible further actions. Finally, in 2020, the current Critical Raw Material List was published.

All these lists were (and still are) supposed to help the European trade in various ways:

- Strengthening the competitiveness of European industry in line with the renewed industrial strategy for Europe.
- To stimulate the production of CRMs by enhancing new mining and recycling activities in the EU.
- To foster efficient use and recycling of critical raw materials, a priority area in the EU circular economy action plan.
- To increase awareness of potential raw material supply risks and related opportunities among EU countries, companies and investors.
- To negotiate trade agreements, challenging trade distortion measures, developing research and innovation actions and implementing the 2030 'Agenda on sustainable development and its sustainable development goals'.

2020 was the last year that a critical raw materials' list was set, which was completed up to 30 critical raw materials that appear in Table 1.

2023 Critical Raw Materials (*Strategic Raw Materials in italics*)			
aluminium/bauxite	coking coal	*lithium*	phosphorus
antimony	feldspar	*LREE*	scandium
arsenic	fluorspar	*magnesium*	*silicon metal*
baryte	*gallium*	*manganese*	strontium
beryllium	*germanium*	*natural graphite*	tantalum
bismuth	hafnium	niobium	*titanium metal*
boron/borate	helium	*PGM*	*tungsten*
cobalt	*HREE*	phosphate rock	vanadium
		*copper**	*nickel**

Table 1: List of Critical Raw Materials (European Commission, 2023). HRREs: Heavy Rare Earth Elements; LREEs: Light Rare Earth Elements; PGMs: Platinum Group Metals; copper and nickel are highly strategic but not critical

Other issue that concerns EU and that has encouraged it to develop the critical raw materials' strategy, is that most of those raw materials are produced and supplied from non-EU countries. The percentages of each element can be seen in the graphics of Figure 1 and Figure 2. Figure 1 contains the percentage of the total production of each element that comes from each marked country (for

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global economy supply); for example, around 90 % of all the beryllium produced that supplies the global economy comes from USA or 86 % of LREEs and HREEs are produced by China. Meanwhile, Figure 2 contains the same type of percentages referred to the supply of EU raw materials (EU would only be self-sustaining for strontium).

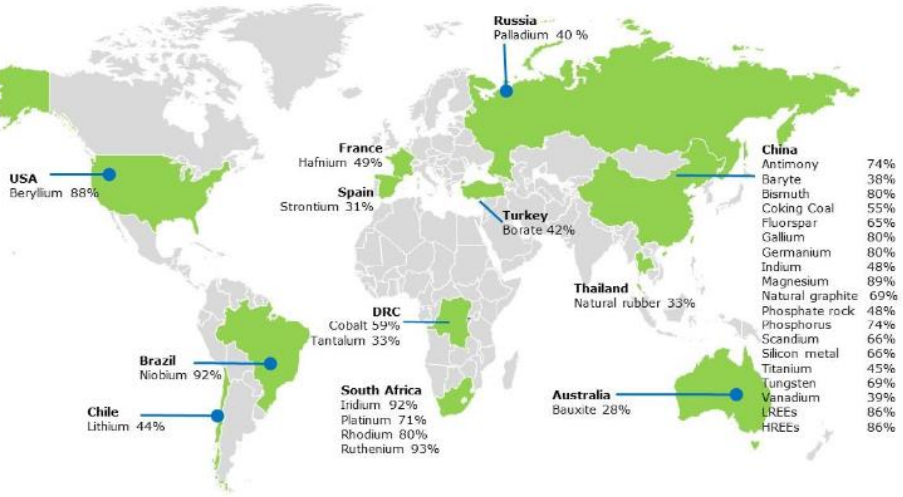

Figure 1: Countries accounting for largest share of global supply of CRMs.

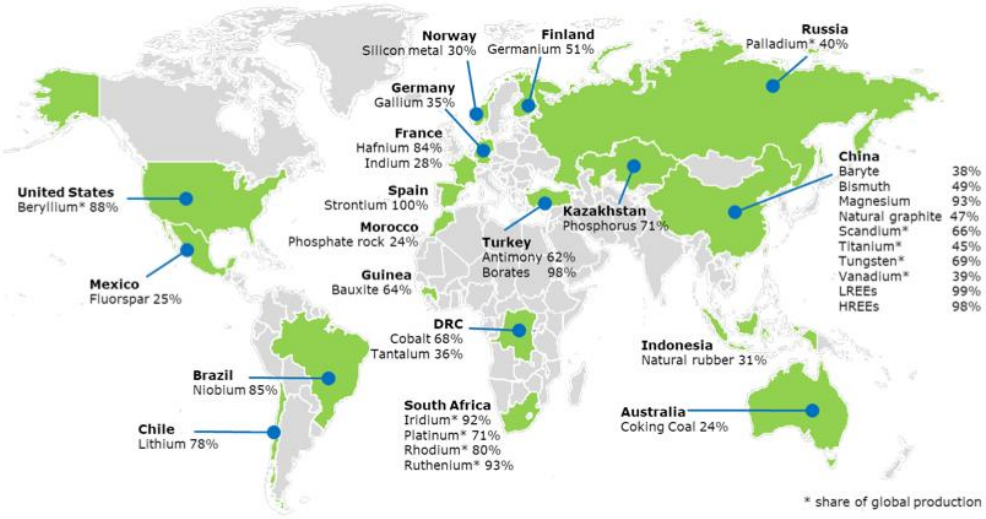

Figure 2: Countries accounting for largest share of EU supply of CRMs.

The European Union needs to ensure a safe and sustainable Critical Raw Material supply, and it is fundamental that companies, authorities and EU institutions work together to achieve this goal. Further investigations about possible substitutes for Critical Raw Materials and residues reprocessing in order to avoid that valuable materials end up in a landfill, are needed. Critical Raw Material supply is a challenge that concerns all of us as they are used in a huge variety of essential devices and technological items of our daily life. That is why it is important for students to get familiar with these materials.

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Learning Outcomes

By the end of the lesson the students will be able to know:

- CRMs economic importance and risk supply.
- CRMs minerals, manufacturing, properties and uses.
- CRMs environmental and social impacts.

Key Competence European Framework

Literacy competence
S1. Ability to understand and interpret concepts, feelings, facts or opinions in oral and written form.
S3. Ability to interpret the world and relate to others.
Multilingual competence
S1. Ability to understand and interpret concepts, feelings, facts or opinions in oral and written form.
S3. Ability to interpret the world and relate to others.
S5. Knowledge of vocabulary, grammar and language.
S7. Ability to use technical language accordingly to the field of work.
Mathematical competence and competence in science, technology and engineering
S1. Ability to use constructed thinking in order to solve a problem in every situation.
S4. Readiness to address new problems from new areas.
S5. Capacity for quantitative thinking.
S6. Ability to extract qualitative information from quantitative data
S8. Ability to design experimental and observational studies and analyse data resulting from them.
Personal, social and learning to learn competence
S1. Ability to pursue and persist in different kinds of learning.
S3. Ability to gain process and assimilate new knowledge, skills and qualification required for career goals.
Citizen competence
S2. Ability to adapt to the changing situation, being flexible and work under pressure
S3. Ability to work effectively and collaborate with other team members
Entrepreneurship competence
S1. Awareness of local, national, European culture heritage and their place in the world

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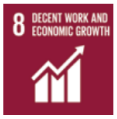
United Nations' Sustainable Development Goals

The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. *Goals linked to this activity*:

	 Enable access to basic services		 Equal access to global expertise
	 Safe medical devices		 Sustainable urbanization
✓	 Access to education	✓	 Responsible consumption and production
	 Less hardship, more opportunities		 Strengthen resilience, reduce disaster impact
	 Safe and affordable water		 Reduce marine pollution
	 Energy – the golden thread		 Sustainable use of terrestrial ecosystems
✓	 Safety of workers and economic growth		 Promote peaceful and inclusive societies
	 Resilient infrastructure and sustainable industrialization		 Better access to technology and innovation

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Contents – Theoretical principles

Appendix 1 – Awareness-raising, environmental and social impacts

Appendix 2 – Fact Sheets

Lab Procedure/Activity

Appendix 3 – Game Instructions

Appendix 4 – Student's Play Cards

Learning Pathway

Step 1 (15 minutes) – Teachers gives a seminar to introduce the concept of CRMs, their challenges and examples of applications and uses.

Step 2 (10 minutes) – Game rules are explained, students are divided into groups and teams, setting up the game (preferably 3 groups of 3-4 teams and 2-3 students per team).

Step 3 (35 minutes) – Students teams, in turns, try to match as many application-use pairs as possible (there are 3 sets of cards, so they can play up to 3 rounds).

Step 4 (15 minutes) – Students play a Kahoot!

Evaluation

Access to a prepared and structured public "Kahoot!" (Critical Raw Materials Properties&Uses, created by the user EITRMSchools). The teacher can save the results of the students' scores for the evaluation.

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Description of Student's Cards

Appendix 4 – Student's Play Cards

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Acknowledgement

This document has been prepared by: Miguel Izquierdo Díaz*, David Bolonio, Ignacio Laorga, Andrea Ruiz, Ljiljana Medic, Christian Peña, Isabel Ámez, Blanca Castells

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