

EXPLORE THE BRIEFCASE - LEARNING ABOUT RAW MATERIALS THROUGH NON-CONVENTIONAL TEACHING TOOLS

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Abstract: We live in a material world where the markets are flooded with all kinds of products. At the same time, we are facing a population growth, as well as a product demand growth. But, are we aware of the raw materials needed for our favourite daily products? In which part of the world are they extracted? Do we recognize the value chains from the mine to the product? And, where do these products end up after we use them? Many school curriculums include this topic only briefly, thus there is a need to raise awareness among youngsters about mining and raw materials in general. EIT RawMaterials funded by the European Commission, is the largest community dealing with raw materials in Europe. One of its main objectives is to raise awareness among general public about the raw materials and their indispensability, about the consequences of their uses, about the mining and production systems as well as about the utilization and recycling. Innovative and attractive pathways are employed in the process. One of the projects bringing raw materials and mining closer to pupils is the BRIEFCASE project. Using non-conventional teaching methods, tools and guided workshops, the project provides pupils with a unique hands-on experience. It draws their attention to raw materials and their applications and helps pupils recognize minerals in products we use every day. Besides emphasizing the importance of minerals in our everyday life and addressing sensible issues like conflict minerals, the consequences of our purchase decisions, the sustainability of mining operations and their environmental implications are also presented.

Key words: BRIEFCASE project; raising awareness; minerals; non-conventional teaching tools; EIT RawMaterials; sustainability

1. INTRODUCTION

We are surrounded by materials built into different electronic equipment (e.g. computer, radio, mobile phone and other household appliances), kitchenware (e.g. cutlery, plates, magnets on the refrigerator), cosmetics (e.g. powder, toothpaste, nail polish), food (e.g. salt) and others (e.g. pencil, book, glass, aluminium can, coin, cloths, banknotes) in our everyday life. All these products have one thing in common: they are all made of raw materials. Namely, every new-born child will consume over its

lifetime approx. 1.37 million kg of minerals, metals and fuels in total [1]. Furthermore, due to worldwide population growth the overall demand for raw materials is growing and their availability needs to be ensured. Consequently, this causes the increase in waste streams connected to our disused items.

But how well do we know from which raw materials are the products we use every day made, which are in the houses we live in, in the bikes we ride on or in the mobile phones in our hands? Do we

recognize these raw materials, and where they are obtained? Raw materials come from Earth, they are all around us and they have an immense impact on our everyday life.

Exploitation of raw materials has rapidly increased since the industrial revolution, which is marked by progress, science development and technology. Due to the rapidly growing economy, especially in the last two decades, the interest in raw materials has increased as a result of increased consumption and higher prices, as well as the fast-growing economy in new markets such as China or Brazil [2]. Today, ore exploiters in mineral-rich countries control and orchestrate market relationships and play an important role in global economic and political decisions.

Under these circumstances securing a sustainable supply of raw materials is a key priority for the EU. Raw materials, such as metals and minerals, have become increasingly important to the EU's economy, growth, and competitiveness. More than 30 million jobs in the EU and many key economic sectors, such as automotive, aerospace and renewable energy, are dependent on a sustainable supply of these raw materials. Raw materials are particularly crucial for the development of modern environmentally friendly technologies and a strong European industrial base. Without them there would not be smartphones, laptops or cars [3, 4].

Europe is known for its high dependence on import of the raw materials, since the EU's annual share of global raw material production is only about 5% [5]. In 2017 European Commission has drawn up a list of 27 raw materials defined as materials important to European economy and associated with supply risks, e.g. antimony, cobalt and scandium. The list of these so called **critical raw materials** is regularly updated depending on current demands. The Commission calls for respect of international trade laws, engages in diplomatic partnerships with producers (as seen in South America among others), finances research initiatives to better the recycling of electronic devices and fosters the creation of European expert networks. These initiatives culminate in new policies which strengthen economic competitiveness while boosting technological innovation and job creation. From 2018 to 2020, Europe will dedicate over 250 million euros to raw materials [6].

Another important group of minerals are **conflict** or **blood minerals**. They are also known as 3TGs (from their initials) and include cassiterite (for tin), wolframite (for tungsten), coltan (for tantalum), and gold ore. The phrase "conflict minerals"

refers to the situation, where the income derived from the trading of these minerals is used to finance armed conflict, fuel forced labour and other human rights abuses, support corruption and money laundering as is the case in the Democratic Republic of Congo and surrounding countries [7]. The most important issue is the origin of these minerals and whether the ore used to produce these base metals comes from the illegal mines controlled by the Government troops and militias. These troops and militias use significant profits derived from the mines to further their own agendas and to perpetuate war through the purchase of weapons. Furthermore, they are responsible for some of the worst atrocities against mankind and gross violations of human rights, including rape, murder and child labour. Civilians from local mining communities are forced to take part in this illegal mining trade [8] working in artisanal mines in slavery or unhealthy conditions.

In order to meet the short- and long-term European demand for minerals, its industry is expected to expand investment, exploration and production activities across Europe. Nowadays society requires primary raw materials, as well as secondary raw materials (SRMs). SRMs include waste material from tailings and heap mining, from processing of raw materials like slags, ashes, skimmings, or sludges, materials removed during production, such as scraps, and all the materials that have reached their life cycle end and can be used repeatedly in production as starting material. There are newly developed and modern environmentally friendly technologies available for the exploitation of the SRMs. Therefore the concept of circular economy, aiming to decouple economic growth from resource consumption and keep products and materials in use as long as possible, does not seem so far away as it used to. SRMs can replace primary raw materials to some extent (from 10% to more than 50%, depending on the raw material itself). The use of SRMs has enormous potential for energy savings, since efficient use and recycling almost always require less energy than primary resource extraction and recovery. Although primary raw materials will continue to play an important role in production processes, even in a circular economy, the uses of the SRMs can help to reduce primary ones, which also need to be preserved for future generations.

On the other hand, mining is perceived in a particularly negative light by the general public. The reason for local communities opposing the mining is the "Not In My Backyard" (NIMBY) phenomenon, which refers to resistance of residents towards

realization of mining activities in their local environment. However, these same residents would still like to benefit from products made from raw materials, just not from those in their local area. The improvement in social acceptance and the public license to operate may be achieved by further development of technological, organizational and scientific methods which minimize mining impacts on the environment and surrounding communities. Additionally, beside bilateral communication, negotiation and cooperation with stakeholders, extensive, in-depth social debates on mineral development

projects in European and non-European countries are necessary [9]. This is why Brussels finances the development of "intelligent" and "sustainable" mining technologies, in order to have new mines in Europe with less pollution of air, water and soil etc. Training and education, entrepreneurship, knowledge management etc., these cross-cutting actions are all of paramount importance for preparing the future. This also includes raising awareness about social importance and dependence on raw materials for our everyday lives.

2. NON-CONVENTIONAL TEACHING TOOLS ABOUT MINERALS – THE BRIEFCASE PROJECT

The original BRIEFCASE is a novel product that has been successfully used by the Spanish Geological and Mining Institute (IGME) for over 15 years. Namely, during their visits to the Geomining Museum youngsters are taught how to recognize minerals and understand their use in daily life. This idea received funding from EIT RawMaterials in 2018.

The BRIEFCASE project [10] (Fig. 1), branded under the RawMaterial Academy (Fig. 2), is a 15 months long project which begun in October 2018. The consortium led by Gomez Pardo Foundation (Spain), consists of eleven partners from seven EU countries, namely Spain, Slovenia, Austria, Italy, Belgium, United Kingdom and Greece. Institutions involved are Ayma Mining Solutions, the Southern Spanish Professional Association of Mining Engineers, the Universities of Coventry, Milano – Bicocca and Leoben, the European Association of Mining Industries, Metal Ores & Industrial Minerals, Fundación Tecnalia Research & Innovation, the Spanish Geomining Institute, Monolithos Ltd. and the Slovenian National Building and Civil Engineering Institute.



Fig. 1. The BRIEFCASE logo



Fig. 2. EIT RawMaterials Academy

The BRIEFCASE is a Wider Society Learning project which raises social awareness of the use of and need for raw materials. These kinds of projects inform, educate and reach out to school children, to the general public, non-governmental organizations and decision-makers across Europe [11]. The project is oriented specifically to primary school pupils aged 6 to 14 and their teachers. Through an innovative popular science the BRIEFCASE project seeks to explain mining activities and mineral applications to the society. Important considerations are dedicated to the NIMBY concept and "mining in equal conditions", as well as to the problem of conflict minerals.

The project seeks to bring minerals and mining closer to society as a whole. Its ultimate goal is for youngsters to understand where the minerals forming daily products come and how our daily purchase decisions affect the social environment of the people who live in countries with resource exploitation. It is impossible to live without minerals and mines, since mining provides us the basic elements of our life and it is often taken for granted. Practical exercises and a friendly approach are used to communicate that mining is a modern activity and its hazardous impacts on the society and environment can be mitigated.

The BRIEFCASE project derives its name from the collection of briefcases containing mineral specimens, everyday products made of these minerals and information hand-outs. The BRIEFCASE educative material consist of several thematic briefcases covering gold, cobalt, phone elements and daily minerals, a virtual version of the BRIEFCASE tool, and several educative workshops like the "gold panning" activity.

The thematic briefcases (Fig. 3) contain a set of minerals, tools for their identification, common products of everyday life and didactic friendly

materials like quizzes and games. The tool teaches pupils to familiarize with and to recognize the most common minerals and their applications with a hands-on experience, to reflect on their own purchasing decisions and empowers them to demand more ethically sound practices of companies, while acknowledging the consequences of the NIMBY phenomenon, which has moved a lot of mining out of Europe.

The “**mobile phone**” exercise (Figure 3) is probably the one with the greatest social impact. It presents the mineral ores from which the parts of mobile phone are made and explains to pupils the conflict minerals built into the phone, namely tin, tungsten, tantalum, gold, cobalt, platinum.

Slovenian National Building and Civil Engineering Institute (ZAG) as an expert in circular economy in construction aims to develop an additional “**secondary raw materials (SRM) BRIEFCASE**” by the end of 2019. It will include various samples of slags, fly ashes, metal chips, tailing residues and others waste materials from mining industry. Also, the tin and the platinum BRIEFCASE are in development and will be presented in November.

The “**virtual BRIEFCASE**” (Fig. 4) is a website application embedded in the Spanish Geological Survey (IGME) website [12]. This application represents virtual repository and hosts a quiz on

the composition and commodities used in ten common products like mobile phone battery, light bulb, toothpaste, soda can and many more. The quiz is currently available in English and Spanish language, and will be translated to Slovenian, Italian, Greek, German and French before the end of the year.



Fig. 3. The “daily minerals BRIEFCASE”, the gold BRIEFCASE, the cobalt BRIEFCASE and the phone BRIEFCASE, including ore minerals and objects

The game of “THE DIDACTIC SUITCASE” aims to familiarize the player with the minerals that are used in the manufacture of everyday objects. To do this, you will find in the suitcase 12 minerals on one side and 12 objects on the other. The player must relate these minerals to everyday objects.

Each mineral in turn will be accompanied by 4 clues that will help you to relate the objects. But the fewer clues you use, the more points you'll get! You have 30 minutes to complete the game.

GOOD LUCK AND PLAY!

Fig. 4. The didactic “virtual BRIEFCASE” website

Another interesting hands-on exercise is the “**gold panning**” (Fig. 5) where pupils use a pan and water to rinse the quartz sand from the pan in hope

of finding valuable minerals like pyrite, magnetite, and other heavy minerals. Gold panning is usually carried out in nature by the river side, however, it is

also demonstrated in the classroom using sand and water filled container instead of a river bed.

Additional material

The project also offers didactic guides, a project leaflet [13] and a short video [14] about the project aim. In addition, a new video will be developed by the end of the year, which will include explanations on how to use the tool.



Fig. 5. Gold panning exercise

3. THE BRIEFCASE WORKSHOPS

Topics covering mineral resources are included in many school curriculums to some extent but explaining these concepts to pupils can be quite challenging for teachers. Especially, since pupils are not used to seeing minerals and handle them in their natural condition. Therefore, BRIEFCASE consortium carries out workshops which teach youngsters about raw materials, mining and about utility and indispensability of minerals and consequences of their uses and production systems. In order to boost pupils' interest in becoming "young minerals detectives" consortium uses a non-conventional learning experience within the BRIEFCASE project.

During the 2–3 hours long workshops, minerals and products manufactured from those minerals are presented to pupils and teachers. Pupils need to match minerals in their raw form with a product made of particular mineral. Clues (hints) to pupils are provided so they can solve the riddle on their own. When identifying the correct pairs we explain to pupils about the minerals' origin, production, history of exploitation in the country (if any), other related products made out of this mineral, etc. Furthermore, we explain how mining is important for all of us despite most of mines being found outside Europe. Therefore, raising awareness about the consequences of the uses of these minerals or production systems of minerals in other countries is of great importance. Topic about conflict minerals is quite distant for pupils, as they are not aware of the effects of mining on people's life, especially children's life in the third world countries.

In order to emphasize the history and importance of past and present mining activities in certain countries, the workshops are held in different parts of Europe (project partners' countries). First one took place in the Kirchlich Pädagogische Hochschule der Diözese Graz-Seckau (Austria)

last September. In the period from October to December consortium plans to offer several workshops and demos across Europe: at Mining and Minerals Hall in Seville (Spain), at the FabLab in Coventry (United Kingdom), during the EU Raw Materials Week in Brussels (Belgium), in Maribor (Slovenia), in Vagoneto (Greece), at the Science Week (Spain), at some schools in Basque country (Spain) and in Milan (Italy). Other cities are welcome to participate in the project and can request partners to present the BRIEFCASE in their countries.

The BRIEFCASE workshops are also dedicated to "teach the teachers" demonstrating them how to use the toolkits and other hands-on materials. The idea is that training can contribute to spreading the raw materials knowledge. It can do so by providing the tools and adequate message to the teachers that can use the BRIEFCASE tool with the new generation of children in an autonomous way. The BRIEFCASE material is available to the academic and education community for free at each partners' institution.

Further project development, synergies and complementariness with other projects

The second phase of the BRIEFCASE project will be the 3D BRIEFCASE project – learning the use of minerals through the non-conventional digital tools. The project extension is funded by EIT RawMaterials and will run from 2020 to 2021. The aim of the 3D BRIEFCASE is to extend the target audience to the 14 to 18 years old students in high schools. The 3D BRIEFCASE will improve the innovative popular science tool – the "virtual BRIEFCASE" in two ways: to upgrade the application to be used with 3D glasses, and to use an augmented reality application on a mobile phone or a tablet.

The BRIEFCASE project complements other educative EIT RawMaterials projects like RawMatTERS Ambassadors at Schools (RM@Schools) [15], Teaching Raw Materials through Gamification (BetterGeoEdu) [16], Sustainable Management of Critical Raw Materials (SusCritMat) [17] and the VirtualMine [18]. Furthermore, the BRIEFCASE project also complements other EU

funded projects like Minerals4EU [19], and MIN-GUIDE [20]. The BRIEFCASE project provides an additional content for education on the social behaviour in order to prevent some of the consequences of mining in remote countries, which will be transmitted through a disruptive tool which provides autonomy to the teacher for training in future.

4. CONCLUSION

Youngsters are a driving force for the future and also future innovators therefore the BRIEFCASE project aims to raise awareness among them and additionally among teachers. The project focuses on the utility and indispensability of minerals and mining, as well as on the consequences of their uses and production systems. Furthermore, the sustainability of the mining operations, the importance of the consumer's behaviour, the effects of consumption, as well as recycling opportunities are discussed. Project guided workshops provide pupils with a unique hands-on experience with minerals and their applications and help them to recognize minerals in items they use every day. Additionally, the project aims to emphasize the social and environmental consequences of our purchase decisions for those people that live and work in the countries where mineral resources are extracted. The meaning of NIMBY concept is brought to their attention thus improving the social acceptability of mines.

About the EIT RawMaterials

Activities mentioned in this paper are supported by the European Institute for Innovation and Technology (EIT) established in 2008, as an independent body of the European Union. Its main task is to foster cooperation between business, education and research institutions (the knowledge triangle), thus creating an appropriate environment for innovation and entrepreneurship in Europe. The Institute

currently has eight Knowledge and Innovation Communities (KICs) that focus on current social challenges: climate, digital technology, health, nutrition, innovative energies, raw materials, urban mobility and manufacturing. The community for raw materials is EIT RawMaterials, with an ambitious mission, to change the dependence on raw materials into Europe's strategic power. This should be achieved by fostering the competitiveness and the growth of the European raw materials sector, in particular through radical innovation and entrepreneurship. The most important areas are: (a) research and assessment of the potential of European raw materials, (b) mining and demanding environments and innovative, sustainable mines, (c) increased material efficiency in mineral and metallurgical processes, (d) substitution of critical substances in products and their optimization, (e) the recycling and optimization of value chains for better products, and (f) the planning of circular economy products and services.

The community is made of core, associated and project partners. Institutions and companies may also apply for funding even if they are not part of EIT RM community by liaising with one of the core or associate partners and participating in EIT Regional Innovation Scheme (RIS) projects as partners to carry out individual project tasks (task partners).

More information on the EIT RawMaterials community is available at:

<https://eitrawmaterials.eu/>



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Disclaimer

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Резиме

ИСТРАЖИ ЈА АКТОВКАТА – УЧЕЊЕ ЗА МИНЕРАЛНИТЕ СУРОВИНИ ПРЕКУ НЕКОНВЕНЦИОНАЛНИ НАСТАВНИ АЛАТКИ

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Клучни зборови: протект АКТОВКА; подигање на свеста; минерали; неконвенционални наставни алатки; ЕИТ минерални суровини; одржливост

Живееме во материјален свет каде пазарот е преплаван со различни видови производи. Во исто време се соочуваме со пораст на населеноста, како и со зголемување на побарувачката. Но дали сме запознаени со минералните суровини неопходни за нашите омилен секојдневни производи? Во кој дел од светот се ископани? Дали го препоз-

наваме синцирот на вредности од рудникот до производот? И, каде завршуваат тие производи откако ќе ги искористиме? Многу школски наставни програми ја обработуваат оваа тема накратко, така што постои потреба од подигање на свеста помеѓу младите, за рударството и минералните суровини воопшто. ЕИТ Минерални Суровини (EIT Raw

Materials) најголемата заедница која се занимава со минералните сировини во Европа, финансирана е од Европската Комисија, и. една од нејзините главни цели е подигање на свеста кај пошироката јавност за минералните сировини и нивната неопходност, за последиците од нивната употреба, за рударството и производството, како и за нивното користење и рециклирање. Во овој процес се користат нови и привлечни пристапи. Еден од проектите што ги доближуваат минералните сировини и рударството поблиску до учесниците е проектот АКТОВКА. Користејќи неконвенционални наставни методи, алатки и насочени работилни-

ци, проектот им нуди на учениците уникатно практично искуство. Го привлекува нивното внимание кон минералните сировини и нивната примена и им помага на учесниците да ги препознаваат минералите во производите што ги користиме секојдневно. Покрај тоа што се потенцира важноста на минералите во нашиот секојдневен живот и се дава осврт на осетливите проблеми како што се штетните минерали, прикажани се и последиците од нашиот избор на начинот на нивно добивање, одржливоста на рударските операции и нивните импликации врз животната средина.