

THE IMPORTANCE OF EDUCATION ON MINERAL RAW MATERIALS FOR MORE SECURE AND ENJOYABLE TOMORROW

Lidia Gullón Corral¹, Santiago Rosado Calderón², Luis Jordá Bordehore³, Kim Mezga⁴

¹*Foundation Gómez Pardo, Calle Alenza, 1, 28003 Madrid, Spain*

²*Minería es Más, Calle Ríos Rosas, 21, 28003 Madrid, Spain*

³*Technical University of Madrid, 28003 Madrid, Spain*

⁴*Inštitut SeMe, okoljsko ozaveščanje in trajnostni razvoj,
Poljčane, Partizanska ulica 14, 2319 Poljčane, Slovenia
kim@i-seme.si*

A b s t r a c t: Mineral raw materials represent the basis for our everyday goods, e.g. food, cosmetics, clothing, medicine, mobile phones, electrical appliances, vehicles, construction materials, fertilizers, jewellery, etc. Furthermore, mineral raw materials are essential for new solutions for modern infrastructure and technologies and are indispensable for reaching the Green Deal goals of a climate-neutral society by 2050. In fact, the more ambitious climate targets are, the more minerals are needed for clean energy transition. Since the mineral consumption in general is rising, there is a need to educate society, especially children, on these topics. School curriculums often lack these topics, in particular while addressing recycling and circular economy. The RISBriefcase project, with its non-conventional teaching tools, is applying the holistic approach on this matter by teaching children about mineral properties and their uses, critical raw materials, circular economy approaches and use of secondary raw materials, sustainable mining, gender equality and a variety of career opportunities in mining sector.

Key words: RISBriefcase project; minerals; mining; non-conventional teaching tools; education

1. INTRODUCTION

Mineral raw materials are non-renewable natural resources, which are used to produce finished goods that we use and encounter daily. They are inextricably linked to the rise of mankind and civilization and its importance is documented in the names of ages of mankind based on materials used (e.g., copper age, coal age, etc.) [1]. In recent years, the mineral consumption by society has increased by 2–5% [2]. In the European Union alone, 16 tons of mineral raw materials are consumed per person per year [3]. However, mining activity and mineral resources remain an unknown topic for society in general, especially for children. Although children are strongly educated in aspects related to biology or animals, there is no such education in the mineral raw materials area, which causes, even with practical experience, to be quickly forgotten by children [4]. Earth sciences in general, geology in particular, have less and less weight in schools. Although soci-

ety in general have knowledge on the origin of mineral raw materials, it is not entirely aware of the relationship between mining and the materials used on a daily basis, more importantly the possibilities of recycling and reuse of metals. In contrast to that, schools are making many efforts to teach students about the paper, plastic and glass recycling, etc... Metals, essential for electronics, batteries, cars, etc., can be recycled and reach the properties of the original product. This content should also be included in school curriculums, since its exclusion from the education system is harming the impact of critical raw materials (CRM) reuse.

This general lack of knowledge is evident in several key aspects: the presence of mines in Europe and the generation of economic resources and jobs in communities in sustainable conditions, the dependence on mineral raw materials and the strong environmental protection.

For years, Europe has been undergoing a process of deindustrialization in favour of developing countries. This is especially concerning in cases such as Spain, which has lost the half of its industry since the late 1970s [5]. It is increasingly difficult to see industry as common practice and a significant part of society is unaware of the mines in our environment [4]. Precisely this deindustrialization has caused a notion in a part of society that mining only generates wealth and work for companies and not for local communities. It should be considered that strengthening European industry and mining not

only reinforces our economy and social satisfaction, but also guarantees sustainable work that is not always available in other countries. Most of the minerals we use are mined outside of Europe, sometimes under poor working conditions, using forced or child labour, in unsustainable or environmentally damaging ways, and often the minerals are the cause of armed conflict, or the source of their financing. Conflict minerals are far away, both geographically and emotionally, and we rarely give any thought to the ethics of the products we buy.

2. WHY THE KNOWLEDGE ON RAW MATERIALS MATTERS

The lack of knowledge about the connection between minerals and our daily life is alarming. Society, not just children, is not aware that the raw materials are necessary for manufacturing everyday products. There is also no awareness of the scarcity of many of these raw materials and how difficult it is for the European Union to obtain them. The society in general is aware of the importance of recycling to avoid waste dumping but is not aware of the importance and value of secondary raw materials.

The need for the knowledge in the field of mining and metallurgy has been widely investigated by the United Nations [6] and the European Commission (EC) [7], both establishing that the growing problem of skill shortage will probably have an impact on the future of the European mining industry [8]; and that there is still a limited public awareness of the importance of domestic raw materials for the EU economy. Young and educated people are leaving areas/countries rich in mineral resources (which is known as brain drain) [9], due to limited possibilities to have a better life; Latvia, Lithuania, Romania, Bulgaria, and North Macedonia are clear examples of this. The EC initiative intends to increase the internal quota of supply for the EU, and for this it is necessary to explore the territory, open new operations and maintain those that already exist and are productive. To encourage these activities, social awareness about mining operations is needed, and it should start with educating the young generations. It is necessary to “socialize mining” – bringing mining closer to society by educating pupils, our future politicians and future citizens, who will teach their parents, and their parents will teach general society. It is necessary for the society to understand the importance of minerals, because it is not possible to continue mining operations without a social licence to operate (SLO).

It is also true that we should not trivialize the process of opening a mine due to both, legal aspects and those specific to an industry. Analysis takes a long time, preventing opening a mine from one day to the next and solve short-term problems. Strategic decisions are required. Possibly the children of today who learn about minerals will be the ones who decide on mining in 20 years.

Perhaps the most unknown and important aspect is the sustainable management, especially recovery activities, which mining companies carry out, although they are, contrary to reality, often seen as major sources of pollution. In Europe, just the construction sector generates 30% of annual waste [10], however this activity is not questioned. Concerns about the environmental impact of industries began already in the 1960s and 1970s. Now, there are different examples of proper mining management, such as the Cabárceno Park (Cantabria, Spain), which is a reference park for nature tourism in Spain [11], or the lake in Puentes de García Rodríguez (La Coruña, Spain), which is the largest artificial lake in Europe with a Blue Flag beach [12].

Although women all over the world have been involved in mining activities for centuries, mining has always been considered as a heavily male-dominated workforce, mainly due to a very male-oriented industry and physically demanding work [13]. Additional factors that contribute to the lack of women participating in the mining industry are the wage gap, not fully defined maternity rights, work in shifts, etc. [14]. With mining technologies constantly being evolved and bringing digitalisation [15] in mining, the sector is striving to contribute to the opportunities to advance gender equality, good working conditions in the sector and variety of career opportunities for women [16].

3. THE MOTIVATION BEHIND THE BRIEFCASE PROJECT

Mineral raw materials represent the basis for everyday products and new solutions for modern infrastructure and technologies. Therefore, in order to bring minerals and mining closer to children, strengthen the knowledge on mineral raw materials and their uses and values in our everyday life, we started the Briefcase project. The project has drawn an idea from the original BRIEFCASE tool, based on the existing tools used by the Spanish Geo-Mining Museum (IGME/CSIC, Spain) and by the Styrian Center of Environmental Education (Austria) during previous years. Both focus on the dissemination of knowledge of raw materials and minerals among students.

The **Briefcase project** (1. 10. 2018 – 31. 12. 2019), branded under the EIT (European Institute of Innovation and Technology) Raw Material Academy, aimed to show to children the reality of the mining sector and mineral raw materials: in particular the origin of our daily products, basic minerals' properties and their origin, the consequences of acquiring products manufactured with raw materials that come from conflict, and the advantages of the mining in Europe (the "Better In My Backyard" concept as a response to the phrase NIMBY – "Not In My Backyard"), where it is possible to monitor and control environmental impacts and the human rights are guaranteed for the employees. Furthermore, it is important to educate children about clean energy transition and higher demand for minerals related with this transition, why Europe wants to increase mineral supply from EU sources (less dependent on imports) and how mining can be sustainable. The truth of the matter is that raw materials are fundamental for maintaining our quality of life and for development of the technologies of the future, especially green ones.

One of the main existing problems with mining education is how unappealing it can be. In addition, it should be considered that since this topic is unknown to teachers, it is much more difficult to make it dynamic for students. The perception of many children (and also adults) of mining activities is related to the presentation from the past – the beginning of the industrial revolution, when the mine work was hard and dirty, and overall dangerous for human health. However, always developing technology has provided tools to improve the quality conditions of the mining workers, with mining currently being a safe operation that provides important development opportunities for the surrounding communities. Briefcase project directly addresses this need and inspires children to follow raw materials careers.

Since the 1990s, a great effort has been made to promote and protect mining heritage. There are numerous and spectacular mining museums and tourist mines across Europe that maintain a fundamental legacy. These mines however, many turned into museums, in many cases showcase the mining of the 19th century. Initiatives, such as the Briefcase project, are already emerging which, together with professional associations, mines in operation and exhibitions (also museums), try to show what mining of 21st century looks like: the transfer of waste to the pit that has already been mined (there are no permanent tailings), the filling of interior works (cut and fill mining), reducing the material footprint, implementation of fossil-free process for mining waste, etc.

The project also encourages students to discover the appeal of geology, metallurgy and mining; it helps show important aspects in the development of their professional careers, such as the difficulty of being a woman in a sector dominated by men, the reward of continuous effort, tenacity and resilience, the importance of setting goals or the influence of our moral values in the development of our work. The project seeks to show mining using friendly approach, avoiding data and complicated speeches. The project aims to be a facilitator of change, providing young ones the necessary knowledge to promote sustainable development, training their behaviour in recycling habits, understanding the climate change, reasonable consumption of resources, the importance of preserving the environment, the "Better-In-My-Backyard" approach, that guarantees the conditions of safety and environmental vigilance in the European mineral deposits.

The methodology of the project is based on the non-conventional teaching tool which includes the hands-on experience accompanied by a set of games and questions [17, 18]. The project is leading the answers of students in a logical reasoning that leads them to understand the need for minerals, also the minerals to be extracted in a fair, sustainable, and environmentally respectful way and, above all, respecting the rights of those who work in the sector. The project emphasizes that the improvement in quality of life obtained thanks to the existence and application of minerals in the first world should not be the burden of sustainability in the third world countries, but rather their engine of development. As customers, we are the engine of change in our purchasing decisions, and for this reason, it is worth reflecting on its consequences.

4. BRIEFCASE CONTENT POPULARIZATION AND UPGRADE

The three editions of the Briefcase project (Briefcase, 3DBriefcase and RISBriefcase) have been co-funded by the EIT Raw Materials, initiated and funded by the EIT, a body of the European Union (Figure 1). Within the **Briefcase project**, the tools and the methodology were developed, providing a solution for the lack of knowledge about the

mining sector and raw materials and raising awareness among children (6–14 years) and society. During the second stage — **3DBriefcase project**, the project extended its impact, by the development of digital tools that are more attractive for older students (15–18 years), reaching a different niche.



Fig. 1. The RISBriefcase project is supported by the EIT RawMaterials and co-funded by the European Union

Physical workshops are the essential part of the methodology, since the main objective is to encourage children to “touch and play” with the minerals. Virtual games provided the tools during the COVID-19 pandemic, facilitating the learning process by enabling digital tools. Despite these efforts, there was one major drawback: the circumstances in each region are different; in some countries, certain resources are well-known, but others are unknown, or the education focuses on certain materials instead of others. Therefore, it is important to join partners from different European countries who can adapt and adjust the tools to their particular needs, as well as reinforce the methodology and contribute positively to the dissemination of the project. The third edition, **RISBriefcase project** (Figure 2), is dedicated to extend the geographical scope to Regional Innovation Scheme (RIS) countries targeted by the EITRM, and offer the new physical tools that will address the challenge of these areas: lack of specialized workforce in raw materials sectors, low ratios of recycling, greener mining, environmental standards, sustainability of operations, etc. This way, the project will be spreading the methodology and the message further.



Fig. 2. The logo of on-going RISBriefcase project

Until now, the project has created the following physical briefcases: Minerals for daily use (Figure 3), Potash and the agenda 2030, Platinum and the importance of recycling, Secondary raw materials, Cobalt and batteries, Tin in our daily life,

Minerals in mobile phones, Gold and conflict minerals, The importance of lead and zinc in our lives, The exploration briefcase, The importance of industrial minerals in our lives, Magnesite and the importance of magnesium products, Critical raw materials briefcase and Vulcano briefcase [17,18]. All three above mentioned projects are using the **Briefcase methodology**, which is based on an interactive and fun “hands-on workshops” for children (Figure 4), utilizing tools with which they can touch and play with minerals.

Beside the physical briefcases, there is also the virtual briefcase game “**The briefcase of mineral application**” [19] (Figure 5), which offers players two levels and is currently translated into 31 languages: English, Macedonian, Catalan, Finnish, Swedish, Euskara, Slovak, Portuguese, Romanian, Polish, Norwegian, Dutch, Czech, Bulgarian, Japanese, Arabic, Spanish, Italian, Slovenian, Greek, German, French, Vietnamese, Galician, Russian, Chinese, Hindi, Tamil, Ladino, Hebrew, and Estonian. By the end of 2023, new partners and task partners will add translations into Bosnian, Serbian, Croatian, Albanian, and Hungarian languages.

Additional tool, developed within the 3DBriefcase, was the **augmented reality (AR) tool** that consists of an App that can be downloaded on an Android phone together with a book containing minerals that can be watched in augmented reality on the mobile phone. You can watch the minerals in the physical book or on the computer with the phone. The book is available in several languages (Greek, Spanish, Slovak and English).

In addition, the 3DBriefcase provides a **virtual experience in visiting a mine** (Figure 6). The underground gold mine located in Spain (Orovalle) was recorded and the video can be watched in 360°

as an immersive virtual experience using 3D glasses, or using the phone combined with cardboards. This application allows uploading new videos, so any mining company interested in collaboration can provide 360° videos of their own operations that can be uploaded and enjoyed by the players.

Finally, the project has developed a collection of materials to provide truthful information to

teachers using the Briefcase tools. Sustainable Development Goals (SDGs) and Climate Change are explained in a collection of sheets available on the project website [20]. Several informative and promotional videos about raw materials, webinars to train teachers about how to use the Briefcase tools or how to lead a panning workshop can be found on the YouTube channel of the project



Fig. 3. Hands-on tool – minerals for daily use and fluorescent minerals



Fig. 4. The workshop with the minerals for daily use, Slovenia



Fig. 5. The banner for the Briefcase game



Fig. 6. Experiencing the virtual mine with VR Glasses

5. BROADENING INTERNATIONAL NETWORK

The Briefcase and its follow-up projects, 3DBriefcase and RISBriefcase, are coordinated by a non-profit Spanish organization Fundación Gómez Pardo, which has established synergies with another non-profit organizations such as i-SeMe (Slovenia), Minería es Más (Spain), Geólogos del Mundo (Spain) and Women in Mining (Spain). These partnerships have allowed the project to complement and enhance the activities of these entities, while also increasing its own impact by developing complementary activities.

Collaborations with these organizations have proven to be useful in reinforcing and improving the Briefcase methodology. For instance, Geólogos del Mundo has provided the gold-panning workshop, which has become a complementary activity of the project. Minería es Más has adapted the game for use in Instagram stories, reaching a wider and younger audience for the project promotion and participation. i-SeMe brings some fresh experiments with minerals to encourage curiosity and get children's attention. Women in Mining has supported the project indicators related to gender equity, taught us how to focus girls during the workshops and promoted the performance of workshops in Spain.

Competent professional bodies, such as the Professional Association of Mine Engineers of the South of Spain (Surminas) or the National Associations of Geologist, and also Enterprise Associations such as Association of Research, Extraction, Mining-Metallurgical, Auxiliary and Services Transforming Companies of Andalucía (Aminer), and the European Association of Mining Industries, Metal Ores & Industrial Minerals (Euromines), have also played a relevant role in supporting the project by funding tools, either spreading the project's message and engaging mining industries in the cause.

Finally, private foundations are the socially responsible arm of the mining companies, and end-users of the project tools. Cobre Las Cruces foundation has joined the Briefcase stakeholder group by replicating and using the tools and by providing access to some relevant events for the project promotion.

The importance of these collaborations is not just to develop specific tools for the Briefcase methodology, but also to allow each partner to develop tools to engage and educate different target audiences. Furthermore, as more associations and individuals become involved in the project, even small contributions from each participant can lead to a

constant dissemination of the project through various social media channels, leading to greater success.

The Briefcase project has already gained a significant impact through its presence in various publications, including the recurrent feature in the *Más Minería* magazine [21]. Additionally, it has participated in several conferences and fairs. The project partners were invited by Euromines to the Mining and Metallic Hall of Seville 2022, to the Cave-Tour of Pulpí by Surminas, to the Hannover Messe, by the European Commission to the EU Open Day in Brussels (Figure 7), and to the most recent Science Fair of Seville in Spain (Figure 8), etc.



Fig. 7. The Brussels EU Open Day 2023



Fig. 8. Workshop at the Science Fair of Seville, Spain, 2023

These partnerships with non-profit organizations provide a great opportunity to amplify the project's reach and impact, making it possible to disseminate the message more widely and effectively, and ensuring the project sustainability, since they integrated the project tools in their daily activities and programs, being part of the Briefcase network for future.

6. CONCLUSIONS

General public, especially children, our future generations, need to be educated on mineral raw materials and mining. The reasons for this are several. First and foremost, mineral raw materials represent the basis for everyday products in our daily life and new solutions for modern infrastructure and technologies. Second, minerals are indispensable for reaching the Green Deal goals of a climate-neutral society by 2050. In fact, the more ambitious climate targets, the more minerals are needed for a clean energy transition. Third, Europe is facilitating domestic mining and production in order to become less independent on the mineral raw materials import. Fourth, with new technological advancements in the mining industry, improving the sustainability of mining activities, providing improved working conditions, gender equality, satisfactory work in the sector, and variety of career opportunities for woman. Finally, the mining sector is addressing new environmental regulations which are mitigating the environmental impacts and are becoming, overall, more environmentally friendly. Last, but not least, the overall image of mining from the past needs to be improved since lack of knowledge about mineral raw materials, mismanagement, as well as poor judgement in the past, have given the mining sector a bad reputation. These are only a few of the many important issues that general public should be educated about.

Today, there are numerous educational tools available, physical and digital, about minerals and

their daily uses. Since the confinements of COVID-19 pandemic at the educational level and in the family entertainment, there has been an expansion in board games and on-line experiments. What stands out with the Briefcase tool is its hands-on experience, which is almost contradictory to see nowadays in the digital era. The digital world and the "touch" / physical world complement each other very well through the concept of flipped classroom and hybrid teaching. The RISBriefcase project is clearly oriented to this paradigm, through its physical briefcases and hands-on experiments, which are complemented by VR Googles and virtual games. In fact, a regular workshop organized within the project contains several stations, each one with the possibility of developing a different game, some physical and others virtual. Furthermore, the project's additional value lies in the dedication of its project partners. Their strong belief in holistic and up-to-date approach in sharing information on minerals and mining, can shed a light on mining nowadays and consequently improve the poor portrait of mining's image among general public and children.

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Резиме

ЗНАЧЕЊЕТО НА ЕДУКАЦИЈАТА ЗА МИНЕРАЛНИ СУРОВИНИ ЗА ПОСИГУРНО И ПОПРИЈАТНО УТРЕ

Лидија Гулón Корал¹, Сантиаго Росадо Калдерон², Луис Јорда Бордехоре³, Ким Мезга⁴

¹Фондација Gómez Pardo, Calle Alenza, 1, 28003 Мадрид, Шпанија

²Minería es Más, Calle Ríos Rosas, 21, 28003 Мадрид, Шпанија

³Технички Универзитет Мадрид, 28003 Мадрид, Шпанија

⁴Институтот СеМе, еколошка свест и одржлив развој,
Пољчане, Партизанска улица 14, 2319 Пољчане, Словенија,
kim@i-seme.si

Клучни зборови: проект RISBriefcase; минерали; рударство; неконвенционални наставни алатки; образование

Минералните сировини претставуваат основа за нашите секојдневни добра, на пр. храна, козметика, облека, лекови, мобилни телефони, електрични апарати, возила, градежни материјали, ѓубрива, накит итн. Понатаму, минералните сировини се од суштинско значење за нови решенија за модерна инфраструктура и технологии и се неопходни за постигнување на целите на зелениот договор за климатско неутрално општество до 2050 година. Всушност, колку поамбициозни се климатските цели, толку повеќе минерали се потребни за транзиција на чиста енергија. Со оглед на тоа што потрошувачката на минерали општо

расте, постои потреба од едукација на општеството, особено на децата, на овие теми. На училишните наставни програми овие теми честопати им недостигаат, особено кога се однесуваат на рециклирањето и циркуларната економија. Проектот RISBriefcase, со своите неконвенционални наставни алатки, го применува холистичкиот пристап кон ова прашање преку учење на децата за својствата на минералите и нивната употреба, за критичните сировини, пристапите кон кружната економија и употребата на секундарни сировини, одржливото рударство, родовата еднаквост и различни можности за кариера во рударскиот сектор.