

МАКЕДОНСКО ГЕОЛОШКО ДРУШТВО СКОПЈЕ 1952
MACEDONIAN GEOLOGICAL SOCIETY SKOPJE 1952

5^{-ти} КОНГРЕС / 5^{-th} CONGRESS

на / of the

Геолозите на Република Северна Македонија
Geologists of the Republic of North Macedonia

**ЗБОРНИК НА ТРУДОВИ
PROCEEDINGS**



Уредници / Editors:

Серафимовски, Т. & Боев, Б.
Serafimovski, T. & Boev, B.

Охрид, 2024 / Ohrid, 2024

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ПРЕДГОВОР

Почитувани гости, колеги геолози и љубопитни души,

Добредојдовте на 5-тиот Конгрес на геолозите на Република Северна Македонија - интелектуално патување кое ги надминува границите, епохите и карпестите формации. Додека сите ние се собираме под знамето на минатата историја на Земјата и нејзината сегашност која постојано се развива, да тргнеме на патување кое ги обединува науката, “чудата” и откритијата.

Љубопитноста е она што не води и во исто време таа е и нашето наследство.

Геолошкиот конгрес е местото каде идеите би можеле да се судрат како тектонски плочи, предизвикувајќи сеизмички промени во разбирањето. Нашиот Конгрес не е само социјално дружење туку во 2024 тој е раскрсница на дисциплини. Момент кога треба да размислуваме не само за старите седиментни слоеви, туку и за итните предизвици на нашето време: климатските промени, недостигот на ресурси и деликатниот танц помеѓу човештвото и природата. Ако порано се трудеме со релативните методи да ги истражуваме и дешифрираме “тајните” пораки врежани во минералите и фосилите, денес во нашите лаборатории зујат спектрометри, а над нас летаат дрoнови со опции за термичка обработка на податоци, картирање и 3D моделирање. Тоа се денес алатките на модерната геологија.

Нашиот Конгрес не е само за карпи и минерали, туку всушност се работи за луѓе. Геолозите од секое катче на нашата држава и поширокото опкружување, без разлика дали се облечени во теренски чевли или во лабораториски мантили, на ова место се спојуваат и споделуваат. Споделуваме податоци, разменуваме приказни и поттикнуваме соработки. Во светлите

PREFACE

Dear guests, fellow geologists and curious souls,

Welcome to the 5th Congress of Geologists of the Republic of North Macedonia - an intellectual journey that transcends borders, eras and rock formations. As we all gather under the banner of Earth's past history and its ever-evolving present, let us embark on a journey that unites science, "wonders" and discoveries.

Curiosity is what guides us and at the same time it is our heritage.

A geological congress is where ideas could collide like tectonic plates, causing seismic shifts in understanding. Our Congress is not only a social meeting, but in 2024 it is a crossroads of disciplines. A moment when we should think not only about the old sedimentary layers, but also about the urgent challenges of our time: climate change, the scarcity of resources and the delicate dance between humanity and nature. If earlier we tried with relative methods to research and decipher the "secret" messages engraved in minerals and fossils, today spectrometers buzz in our laboratories, and drones fly above us with options for thermal data processing, mapping and 3D modeling. These are the tools of modern geology today.

Our Congress is not just about rocks and minerals, it's really about people. Geologists from every corner of our state and the wider environment, regardless of whether they are wearing field shoes or lab coats, come together and share in this place. We share data, exchange stories and foster collaborations. In the bright halls of the convention center, continents collide and ideas crystallize.

As we gather for fellowship together, remember: The Earth Atlas remains unfinished. There are peaks unclimbed, faults unknown and mysteries lurking beneath ocean trenches. Our task is to fill in those blanks—to map not only

али на конгресниот центар, континентите се судираат и идеите се кристализираат.

Додека се собираме за заедничка дружба, запомнете: Земјиниот атлас останува недовршен. Има врвови неискачени, раседи непознати и мистерии кои демнат под океанските ровови. Наша задача е да ги пополниме тие празни места - да ги картираме не само геолошките форми, туку и нашата издржливост и надеж за опстојување во се покомплексното глобално опкружување. Да се сплотиме во таа долгорочна и постојана експедиција. Без разлика дали сте искусен геолог или само геолог почетник чија љубопитна душа со чудење гледа во планините, овој Конгрес ве поканува. Да истражуваме, да дебатираме и да не оставиме недоречености. Ајде заедно да го напишеме следното поглавје на Земјата. Нека науката и љубопитноста бидат нашиот геолошки компас.

Ве поздравуваме со пораката “Ајде да истражуваме подлабоко и пошироко - заедно“

**Претседател на Македонско
Геолошко друштво:**

Академик Проф. д-р Блажо Боев

geological forms, but also our resilience and hope for survival in an increasingly complex global environment. Let's unite in that long-term and permanent expedition. Whether you are an experienced geologist or just a novice geologist whose curious soul gazes at the mountains with wonder, this Congress invites you. Let's research, debate and leave no ambiguity. Let's write Earth's next chapter together. Let science and curiosity be our geological compass.

We welcome you with the message "let's explore deeper and wider – together"

**President of the Macedonian
Geological Society:**

Academic Prof. d-r. Blazo Bоеv

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Abstract

This World is material without any doubts, we're surrounded by products, from our morning coffee cups to our trusty smartphones. Imagine your smartphone: its screen contains rare earth elements, its battery relies on lithium, and its casing is made of aluminum. But how often do we stop to think about where these items come from? All these materials come from mining. Where are these raw materials extracted? How do they journey from mine to product? And what happens to them after we're done using them? The BRIEFCASE project is like a treasure chest of knowledge for pupils and draws pupils' attention to raw materials and their applications. Imagine kids exploring minerals like detectives. “Hey, that's feldspar in my phone screen!” or “Whoa, copper in my headphones!” It's like a mineral scavenger hunt. Educating younger generations about these materials is crucial. When they understand where their everyday products come from, they can make informed choices that impact social and environmental well-being. As a contribution to this complex project North Macedonian team from the Goce Delcev University prepared multiple contributions: two mineral briefcases composed of minerals and objects of their applications (enclosing total of 31 minerals and much more objects of their daily use), organized two workshops for primary school pupils and first year students, translated the Briefcase book of daily minerals (Augmented Reality Book) in Macedonian, promoted The Briefcase of minerals on-line game (available in 42 languages, including Macedonian), as well as promoting the project and University events.

INTRODUCTION

Teaching natural sciences is fundamental, as it permeates every aspect of our lives. Our understanding and interaction with the world heavily depend on it, influencing our thinking, living, and decision-making processes (Darling, 2011). Teachers play a crucial role in shaping pupils' perception and comprehension of nature and its laws. It is essential for educators to convey knowledge in a clear and comprehensible manner, incorporating practical examples to enhance learning. Depending on the topic, teachers may choose from various teaching methods, including traditional learning environments or modern approaches such as virtual reality and gamification. Also, learning about mineral raw materials is particularly vital, as these

non-renewable resources, apart from key for the development of the technologies of the future, are integral to our food, clothing, cosmetics, medicine, vehicles, and infrastructure. To engage students in this topic through unconventional means, the RIS-Briefcase consortium has developed specific methodology and an array of excellent physical and digital materials for use in natural science classes, including geography, biology, chemistry, and physics.

The main idea behind the RISBriefcase project¹ (co-funded by EIT Raw Materials under PN 22022) and its diverse approaches to the target groups is to bridge the gap between minerals, mining and society (Mezga et al., 2019; Mezga et al., 2021, Gullón Corral, 2023).

¹ <https://briefcase.eitrawmaterials.eu/>

Such a gap between geology and mining on the one hand, and society represented by the non-governmental sector on the other hand, has reached its climax in the last few years in Republic of North Macedonia, which negatively manifests itself in several spheres of daily life. Just imagine a world where everyone knows the origin of minerals that are used in everyday life and their impact on resource-rich nations. In that direction, the Mineral Briefcase method aims to transform education by enabling students, learners and interested parties to identify minerals and reflect on ethical corporate practices in the application of those minerals. Such an approach aims for more than learning. In this way, it is expected to improve the perception of sustainable mining when the Social License to Operate (SLO) has become one of the key challenges. In addition, one of the goals is through this project to kindle a desire and passion for careers in the field of geology and mineral resources and foster eco-conscious behaviour by organizing interactive workshops. The briefcase tools developed during the project address sensible matters identified as specific challenge of the regions participating.

CONTRIBUTION OF THE NORTH MACEDONIAN TEAM TO THE RIS BRIEFCASE

In the second half of 2023, the Faculty of Natural and Technical Sciences, “Goce Delčev” University in Štip (UGD, R.N.Macedonia) became a task partner to Institute SeMe (i-SeMe, Slovenia), as part of a large consortium of 26 partners, led by the Foundation Gómez Pardo (FGP,

Spain). This was an excellent opportunity to contribute the best manner possible to develop the hands-on and digital educational tools, as well to promote some of the North Macedonian geology and mining.

The newly created physical Briefcases

The primary objective was to develop the first Briefcase of the most common minerals of Macedonia and their applications (Macedonian Briefcase), serving as an interactive tool for educational and promotional purposes (Figure 1). The team invested considerable time and effort to curate local minerals and suitable objects that demonstrate the applications of such minerals in manufacturing products daily used by the most of us. The focus was to ensure that the briefcase would be accessible and engaging for pupils and young learners, enabling them to identify and understand key minerals from the Republic of North Macedonia based on their properties and main applications.

The Macedonian Briefcase comprises 21 minerals, accompanied by tables with identification clues and a series of objects to facilitate the learning process. Additionally, it includes cards that not only name each mineral but also provide information about their deposits. Each mineral is further supported by a photograph and a QR code that links to additional information. N. Macedonia

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| <p>CORUNDUM, α- Al_2O_3</p> <p>Origin of the name: From the Indian word kauruntaka.</p> <p>Form of appearance: Appears in thin and thick-plate hexagonal crystals. It can be colorless-leucosapphire, blue-sapphire, yellow-oriental topaz, red-ruby, green-oriental emerald, violet-oriental amethyst, alexandrite-daylight- ina blue, and under another light red. Luster diamond-like, mother-of-pearl or vitreous. Hardness 9, and density 4-4.01 g/cm³.</p> <p>Main characteristics: Hardness and absence of splitting. It does not dissolve in acids.</p> <p>Occurrence: Occurs in mica and chlorite slates, calcite and dolomite marbles, gneisses, nepheline syenites and granites, as well as sediments.</p> <p>Locations: Macedonia (Sivecs), Burma (Mogok), Sri Lanka (Ratnapura), Japan, Afghanistan, Madagascar, India, South Africa, Russia, Greece, Turkey, etc. The largest ruby 690 g was found in the sands of the Irrawady River in Burma. which is in the Museum of London.</p> <p>Uses: Used as a gemstone. The mixture of corundum, hematite, magnetite and quartz is called emery and is used as an abrasive material.</p> | <p>Sivec mine, R. N. Macedonia</p> <p>More information:</p> <p>RIS⁺ Briefcase of mineral applications</p> <p>Co-funded by the European Union</p> | <p>Corundum</p> <ol style="list-style-type: none"> 1. In jewelry industry is used as gemstone. 2. When occurs as a gemstone it may have different names, sapphire (blue), ruby (red) etc. 3. When it is not at gemstone grade it is used in manufacturing of abrasives and refractory materials. 4. Due to its hardness and chemical stability, it is used in the production of scratch-resistant windows for electronic instruments, wafers for circuit boards, and many other products. |

Figure 1: Macedonian Briefcase No. 1.

Macedonian Briefcase presents some of the most characteristic minerals of the country, including: quartz, tourmaline, azurite, hematite, magnetite, corundum, sphalerite, galena, chalcopryrite, pyrite, rutile, pyrolusite, chromite, calcite, aragonite, barite, muscovite, biotite, marble, feldspar, and cleiophane.

In 2024, a new version of the Macedonian Briefcase was created aiming to extend the scope of the first one to local minerals with additional applications.

Macedonian Briefcase No. 2 contains 10 minerals from the R. N. Macedonia such as: gypsum, specularite, phlogopite, stibnite, otavite, talc, magnesite, native silver, native sulfur and malachite. Once again, the minerals were accompanied with some tables (including the name and photo of the mineral, name of the deposit from where the particular mineral originates as well as QR code for additional information if needed).



Figure 2: Macedonian Briefcase No.2.

The Briefcase Workshops

In 2024 Goce Delcev University implemented two Briefcase workshops to train teachers with practical training and to train pupils (primary school) and youngsters (first-year university) on the importance of raw materials and their applications. The support was also provided by project partners i-SeMe and FGP.

The first workshop took place at the Goce Delcev University teaching center in Kavadarci (R. N. Macedonia) on 11th April 2024. This workshop was attended by 33 students (approx. 19 years old; Figure 3) of which 17 of them were girls (more than the half part Also, two teachers and five

project partner representatives were present, in total 40 participants. During workshops, different versions of the Briefcases were explained:

- Daily use minerals – Macedonian Briefcase (UGD),
- Critical raw materials Briefcase (FGP),
- Daily uses minerals Briefcase (i-SeMe) and
- 3D Briefcase (i-SeMe&FGP).

Students have shown special interest in all the minerals, but they were intrigued more with their daily use and seeing minerals from a different perspective than usual.



Figure 3: 2024 Kavadarci RISBriefcase Workshop.

The second workshop, held on 12th April 2024, took place at the primary school Vanco Prke in Stip (R. N. Macedonia). It was a pleasure to see the joy of the youngest pupils that they can touch and see the minerals as well as to get familiar with their use in everyday objects and products (Figure 4). This workshop was attended by 21 pupils from the

Elementary School (9 years old; 9 girls and 12 boys) including a teacher and five partner representatives (28 in total)). In addition, this visit to the elementary school allowed a fine opportunity to practice both the physical and virtual Briefcase game (yet another innovative contribution to the Briefcase) with the youngest pupils.



Figure 4: 2024 Stip primary school RISBriefcase Workshop

The participants of the physical Briefcase game (pupils/students) must select a mineral at random from a set of several representative minerals. To ensure the selection process is unbiased, the

minerals need to be concealed under a cloth to prevent visual identification by other participants (Figure 5).



Figure 5: 2024 Stip primary school pupils playing the physical game of minerals and their application.

After selecting a mineral, participants must identify its name using a series of clues based on the properties of the minerals. Initial clues include characteristics such as luster (metallic or not), brightness, etc. Additional clues related to the application of minerals in different areas of human living are often tied to objects discussed or displayed during the presentation. This activity is designed to foster observation, critical thinking, and teamwork among the students. Remarkably, students exhibited a strong enthusiasm for learning and a competitive spirit throughout the game. The enjoyment derived from exploring the fascinating world of minerals was a crucial component of the overall process (see Figure 5).

The subsequent activity involved pupils participating in a virtual Briefcase game². This game is available in 42 languages including Macedonian. The game proposes two levels of difficult to

link minerals and products manufactured with these minerals. In the game, the pupils competed to see who could correctly associate the most minerals with daily objects in less time and allow registering track punctuations. The enthusiasm was evident as hands shot up quickly, with each pupils eager to identify the correct mineral corresponding to common items (Figure 6).

The genuine joy on the children's faces served as the ultimate evidence of our success. As noted by some of our international colleagues, "Today, your faculty has secured its students for the next ten years", which is one of the RISBriefcase goals – to inspire students to study and pursue careers in geology, mining, geotechnology, environment, etc.



Figure 6: 2024 Stip primary school pupils playing the virtual online game in Macedonian language on a big TV screen

² <https://www.thebriefcasegame.eu/>

The Briefcase book of daily minerals (Augmented Reality Book) translation

As it is said in the foreword of The Briefcase book of daily use minerals³, the main intention of it is to serve as a teaching tool. It has intended to be used for teaching geoscience disciplines in schools as well as informing the public about the importance of mining and minerals in our daily lives.

With a specific free app for Android, the minerals of the book can be observed in augmented reality. Bearing that in mind the UGD team translated the book into Macedonian language to make it more accessible to a wider audience in the R. N. Macedonia (Figure 7).



Figure 7: Briefcase book of daily minerals (AR Book).

³ <https://briefcase.eitrawmaterials.eu/virtual-voos>

The AR book in an interactive manner describes numerous minerals (as sources of certain metals) such are: hematite (Fe), lepidolite (Li), diaspore (Al), sphalerite (Zn), chalcopyrite (Cu), cinnabar (Hg), cassiterite (Sn), wolframite (W), native gold (Au), talc, magnesite and quartz. Besides the chemical features of particular

Didactic videos

To get even closer to the general public and present the newly created educational tools (contents of the Macedonian Briefcases No.1 and No.2) two didactic videos^{4,5} and a video on the briefcase workshops⁶ implemented in R.N. Macedonia have been created and are all available on the Briefcase YouTube channel⁷.

Raising awareness of RISBriefcase project activities

The North Macedonian team made efforts to publicize the RISBriefcase on the Goce Delcev's University website⁸, as well as to its social media account⁹. If we are aware of the fact that Goce Delcev University (UGD) has around 8000 students it is an inevitable fact that even

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<https://youtube.com/watch?v=YQm4zepJT M4&feature=shared>

5

<https://www.youtube.com/watch?v=jEXzy msqn70>

6

<https://www.youtube.com/watch?v=qpOobpK SBwc>

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<https://www.youtube.com/channel/UCpBR6ih gjxReMMaWxzOrfMQ>

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<https://fptn.ugd.edu.mk/index.php/mk/vesti/51-fptn-del-od-evropskiot-proekt-ris-briefcase>

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<https://www.facebook.com/FPTNUGD?mi bextid=ZbWKwL>

minerals, the book gives an insight into their use in our daily life as well as places (deposits) from where they are mainly exploited or found. Furthermore, the book encloses brief but concise information about the methods of mining and processing of those minerals.

more younger people will have access and contextual intellectual benefits from the Briefcase innovative tools.

Instead of conclusion

As the ancient Greek physician Hippocrates once quoted “Desperate times call for desperate measures”. To take not one, not two, but several steps forward is necessary to inspire in youth for geosciences and related industries with sound and legitimate information. The attitude “not in my backyard” (NIMBY) in today's modern technological World is not only obsolete but seems redundant, also (Badera, 2014). When today's industrial hunger for Rare Earth Elements (REE), high-tech metals etc., become more and more pronounced we cannot stand indifferent and suffer severe and undeserved blows from so-called “environmentalists”. It is imperative to educate both younger and older generations about the significance of primary mineral resources, their daily applications, and the opportunities for extending their lifecycle through secondary mineral resources, recycling, and renewal processes.

With over 51 thematically diverse physical briefcases created through three projects—The Briefcase (2019), 3DBriefcase (2019-2021), and

RISBriefcase (2023-2024)—the consortia have developed innovative, hands-on educational tools. These briefcases enable teachers to effectively educate students about mineral raw materials and contemporary mining practices. The newly developed thematic Briefcases from North Macedonia, accompanied by pedagogical guides, represent a significant addition to the existing array of educational tools for teachers. They also embody a unique heritage. The importance and value of these mineral resources in our everyday lives should be taught from an early age. By fostering a comprehensive knowledge on mineral raw materials today, it would help us and future generations, to sustainably manage the mineral resources upon which we heavily depend.

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