Universidade do Minho
Escola de Ciências

Johana Andrea Barrera González

Contributions to the educational programme of Costa Quebrada Aspiring Geopark (Northern Spain)

outubro de 2023

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ABSTRACT

Contributions to the educational programme of Costa Quebrada Aspiring Geopark (Northern Spain)

This internship report documents the experience and work carried out at the Costa Quebrada Association, the administrative body of the aspiring UNESCO World Geopark Costa Quebrada (CQAG), located in Cantabria, northern Spain. The geological importance of the region lies in its varied and expressive coastal geomorphology, offering a unique opportunity for the detailed study of coastal erosion processes. Recognizing the need to improve the educational offer in the geopark, this internship focused on developing geoeducation initiatives, mainly in the southern region of the CQAG. Various educational activities were designed to enrich the geopark's educational programme, adapted to its specific needs and characteristics. Two activities were successfully implemented during the internship, aimed at young audiences (aged between 7 and 13), to introduce them to the concept of geological time and emphasize the finite nature of soil as a non-renewable resource. In addition, two educational resources have been designed for future implementation: interpretive content for a geological trail in the Escobedo Valley and a field trip guide for teachers, which respond to the needs of first-year ESO students (12 to 13 years old) at the Ría del Carmen Institute. These resources focus on a karst landscape, highlighting the importance of limestone and its relationship with water in the connection between the various social and natural elements of the environment. These initiatives aim to promote a stronger connection between the local community, visitors, and the Costa Quebrada's natural and cultural heritage, enriching the geopark's educational offer and increasing its visibility to a wider public. On a professional and personal level, this internship has provided valuable experiences, including the development of pedagogical and communication skills, the cultivation of empathy for a more effective application of interpretive content, adaptability, and flexibility in approaching content and practical project management. In addition, the contributions made during this internship have been a source of deep personal fulfillment.

Key words: Costa Quebrada, geoeducation, educational programme, karst landscape.

RESUMO

Contribuições para o programa educativo do Geoparque Aspirante da Costa Quebrada (Norte de Espanha)

O presente relatório de estágio documenta a experiência e o trabalho efetuado na Associação Costa Quebrada, o órgão administrativo do aspirante a Geoparque Mundial da UNESCO Costa Quebrada (CQAG), localizado na Cantábria, norte de Espanha. A importância geológica da região reside na sua variada e expressiva geomorfologia costeira, oferecendo uma oportunidade única para o estudo pormenorizado dos processos de erosão costeira. Reconhecendo a necessidade de melhorar a oferta educativa no geoparque, este estágio centrou-se no desenvolvimento de iniciativas de educação em geociências, principalmente na região sul do CQAG. Foram concebidas várias atividades pedagógicas para enriquecer o programa educativo do geoparque, adaptadas às suas necessidades e características específicas. Duas atividades foram implementadas com sucesso durante o estágio, dirigidas a públicos jovens (entre os 7 e os 13 anos), para lhes introduzir o conceito de tempo geológico e enfatizar a natureza finita do solo como um recurso não renovável. Adicionalmente, foram concebidos dois recursos educativos para implementação futura: conteúdos interpretativos para um percurso geológico no vale de Escobedo e um guia de visitas de estudo para professores, que respondem às necessidades dos alunos do 1º ano do ESO (12 a 13 anos) do Instituto Ría del Carmen. Estes recursos centram-se numa paisagem cársica, realçando a importância da rocha calcária e da sua relação com a água na ligação entre os vários elementos sociais e naturais do ambiente. Estas iniciativas visam promover uma ligação mais forte entre a comunidade local, os visitantes e o património natural e cultural da Costa Quebrada, enriquecendo a oferta educativa do geoparque e aumentando a sua visibilidade junto de um público mais vasto. A nível profissional e pessoal, este estágio proporcionou experiências valiosas, incluindo o desenvolvimento de competências pedagógicas e de comunicação, o cultivo da empatia para uma aplicação mais eficaz de conteúdos interpretativos, a adaptabilidade e flexibilidade na abordagem dos conteúdos e a gestão prática de projetos. Além disso, as contribuições feitas durante este estágio foram uma fonte de profunda realização pessoal.

Palavras-chaves: Costa Quebrada, geoeducação, programa educativo, paisagem cársica.

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Key term definitions

- ✓ ***UNESCO Global Geoparks (UGGp):*** "are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development." (UNESCO, 2023).
- ✓ ***Geoethics:*** involves the study and contemplation of the principles and values that guide suitable behaviors and practices whenever human actions intersect with the Earth system (Di Capua & Peppoloni, 2019).
- ✓ ***Geodiversity:*** Gray (2005) defines this term as "the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (land form, physical processes) and soil features." (p. 5).
- ✓ ***Geoheritage:*** refers to extraordinary or exceptional features of geodiversity, which can include minerals, fossils, rocks, landforms, landscapes, soils, and ongoing geological and geomorphological processes (Brilha, 2018).
- ✓ ***Geotourism:*** is defined as tourism that centers on geological features and can take place in either a natural area or an urban setting (Dowling & Newsome, 2018).

Chapter 1: Introduction

This chapter introduces the importance of geoeducation in geoparks, provides a brief overview of Costa Quebrada's journey as an aspiring geopark, and outlines the objectives of the present report.

1.1 Role of geoeducation in geoparks

In the present-day, there is an urgent need to raise awareness and educate society about the critical importance of preserving and conserving the natural environment. Human activities have led to rapid and significant deterioration of the natural environment (e.g., Iordache et al., 2020). While the focus on protecting and conserving the biotic elements of nature is often emphasized in modern society, it is equally vital to safeguard the abiotic elements for the benefit of future generations. These abiotic elements, such as geological formations and natural resources, not only serve as essential building materials and resources for technological advancements, but they also play a crucial role in education, particularly geological elements that facilitate easy observation and understanding for the general public. Utilizing them for educational purposes, particularly in promoting sustainable development, is paramount.

The poor management of Earth's resources by society and its governments has led to a "planetary emergency". Natural resources are being depleted at a rate that does not allow the planet to recover. The ideal approach is to meet current needs without jeopardizing those of future generations, a fundamental principle in the United Nations' 1987 definition of sustainability. The ramifications of this mismanagement are evident in the profound changes our planet faces today.

To change course in this precarious administration, it is necessary to have citizens capable of making informed decisions that take into account the long-term consequences of their actions (Rieckmann et al., 2017). This is where education at all levels and in all sectors (from preschool to tertiary education and in non-formal and informal education) is key to instilling this mindset in society. Therefore, as a strategy to urgently address the challenges facing our planet, UNESCO's educational sector has promoted Education for Sustainable Development (ESD), which seeks to address environmental, social and economic problems holistically (UNESCO, 2022). This approach encourages individuals to reflect on their actions, act in a sustainable manner in complex situations, and participate in socio-political processes to move societies toward sustainable development and become agents of change

(Rieckmann et al., 2017). ESD empowers individuals to reflect on their actions, navigate complex situations sustainably, and actively participate in socio-political processes, thus propelling societies toward sustainable development (Rieckmann et al., 2017). The concept is an integral facet of quality education, promoting lifelong learning and nurturing the competencies necessary to confront today's global challenges effectively. This educational focus finds a promising approach in UNESCO Global Geoparks (UGGp) (Rossi et al., 2022), where the conservation of the abiotic elements of a territory is actively encouraged by opening geological sites to the public (including schools and institutions) for educational and recreational activities.

The concept of geoeducation targeting sustainable development, constitutes one of the fundamental pillars of UGGps (Catana & Brilha, 2020). As highlighted by one of the Sustainable Development Goals (United Nations, n.d.) – the goal of sustainable cities and communities – fostering such educational endeavours becomes crucial in the quest to create a more sustainable future for the planet. In essence, geoeducation is an educational approach that focuses on geosciences learning (Arrad et al., 2020 and references therein). It serves as a tool to deepen understanding of concepts such as geoethics, geodiversity, and geoheritage (Zafeiropoulos et al., 2021), while emphasizing the significance of locations with high geological interest (Brocx & Semeniuk, 2019). Interestingly, geoeducation[5] and geological heritage are closely connected, as studies demonstrate that geological heritage serves as a valuable didactic resource (Herrero, 2021). This connection makes geoparks, which house abundant geoheritage, ideal territories for promoting geoeducation. It is important to note that geoeducation spans both formal education, within academic and scholarly contexts, and informal education aimed at non-specialized audiences (Catana, 2008, Catana & Brilha, 2020). In UGGps, the communication of Earth Science effectively integrates both educational contexts, with tailored communication strategies to engage diverse target audiences in each setting (Justice, 2018; Geopark Management Toolkit, 2023). In this sense, geoparks not only provide education and training for local pupils within their territory but also offer training opportunities for visitors, particularly through geotourism[5] (Alvarez, 2020). These visitors and tourists can participate in activities designed by the geopark for independent exploration and learning, meeting the demand of visitors who seek to enhance their knowledge and understanding of the landscape (Mao et al., 2009).

While geoeducation can takes place in a classroom or laboratory setting, it is closely and necessarily intertwined with field education (King, 2008), which specifically emphasizes the study of outcrops, landscapes, and ongoing geological processes (Brocx & Semeniuk, 2019). This emphasis on the outdoor is essential because geological features are complex and arise from a diverse array of processes, leading to countless variations. Consequently, geosciences are less easily learned from textbooks compared to other natural sciences (Van Loon, 2008).

However, it is important to underline that the objective of geoparks is not necessarily to create geoscientists but rather to illuminate the connections that exist between biological, human (social, cultural, historical), and geoscientific factors. The educational initiatives within geoparks aim to highlight and celebrate the landscapes, geological formations, and geomorphological resources that make these territories exceptional (Farsani et al., 2014). Geoparks strive to reveal the value of their territories to the public, fostering a sense of ownership and a commitment to care for these regions. The analysis and observation of landscapes serve as essential tools in developing the ability to understand these intricate relationships (Pelfini et al., 2016). By fostering this understanding, geoparks encourage the community to feel a deeper connection to their environment and promote a shared responsibility for its preservation and protection.

The transfer of knowledge within geoparks serves to different purposes: it not only raises environmental consciousness among visitors and tourists (Eder & Patzak, 2004; Farsani et al., 2014) but also provides instruction to the local community residing within the geopark's influence, empowering them to actively contribute to the conservation and protection efforts (Bitschene & Schüller, 2011). Moreover, geoparks, being hubs for knowledge generation and environmental awareness, can play a significant role in the economic development of the region by fostering economic diversification (Farsani et al., 2013). In summary, geoeducation can serve as a bridge connecting sustainable tourism initiatives with environmental awareness, facilitating the transfer of knowledge from scientific communities to the local population, and ultimately reaching the visitors (Farsani et al., 2013).

In conclusion, the role of geoeducation in geoparks is crucial for fostering a deeper understanding and appreciation of the natural environment. It serves as a vital component, bridging sustainable tourism initiatives with environmental awareness. Geoeducation in geoparks play a significant role in raising public consciousness about geological heritage and its intricate connection with other elements of the

territory, thus contributing to a more sustainable future for the planet. By nurturing a stronger bond between individuals and their environment, geoparks assume an essential role in safeguarding and preserving the natural world for the well-being of future generations.

1.2 Background of the Costa Quebrada Aspiring Geopark

The management organization of the Costa Quebrada Aspiring Geopark (CQAG) is the Costa Quebrada Association, which was registered in 2003, after the work done by a previous Working Group for the Recovery of Costa Quebrada (GRCQ). This organization was established in response to the devastating oil spill caused by the Prestige tanker in November 2002, which affected the coastal areas from Galicia until the Costa Quebrada territory in Cantabria. This tragedy served as a catalyst, bringing together a diverse group of individuals, including citizens, volunteers, neighbours, and beach users, who were determined to recover and protect the coastline.

However, the journey towards establishing Costa Quebrada as a geopark project began in 1983 when three geological sites were officially recognized and included in the inaugural IGME's National Inventory of Sites of Geological Interest (Spanish Geological Survey). Building upon this foundation, a group of forward-thinking teachers took the lead in implementing innovative educational projects from 1991 to 1995. These initiatives were designed to raise awareness about local and global environmental issues, paving the way for a deeper understanding of the area's geological significance.

In 1999, a collective effort emerged as teachers, academics, and passionate individuals from the region embarked on a journey to define Costa Quebrada as a Geologic Park. Recognizing the unique qualities of the coastal area, this group proposed the establishment of the figure to the competent authorities. Their objective was to highlight and appreciate the distinctive features and singularities of Costa Quebrada, ultimately seeking official recognition for its geological and environmental significance. In 2005 the Geologic Park was clearly defined, until the first visit of the UNESCO evaluators, when the name changed into Costa Quebrada Aspiring Geopark (CQAG). Over the past few years, the ongoing project has been diligently working towards achieving the UNESCO Global Geopark certification.

1.3 Objectives

The primary objective of this report is to document the contributions done to the CQAG's educational project, as well as the valuable learning outcomes achieved during the internship period.

This report highlights the specific educational activities and proposals that were designed, sheds light on the challenges that were encountered, and showcases the professional growth attained through immersive hands-on experience. Thus, the secondary objectives are the following:

1. To describe the specific contributions made to the CGAG's educational department.
2. To analyse the challenges encountered during the internship and discuss strategies used to overcome them in the context of geoeducation.
3. To reflect on the professional growth and personal development achieved through hands-on experience in the field of geoeducation.
4. To share insights and lessons learned from the internship experience to contribute to the knowledge base and future improvement of geoeducation initiatives.
5. To provide recommendations for enhancing the effectiveness and impact of geoeducation in CQAG, based on my internship experience and observations.
6. To promote awareness and understanding on the importance of geoeducation in fostering environmental conservation, sustainable tourism, and community engagement in geoparks.

Chapter 2: Overview of Costa Quebrada Aspiring Geopark

Costa Quebrada Aspiring Geopark (CQAG) is located in the central coast of Cantabria, north of Spain (Figure 1A). Renowned for its outstanding geological and natural features, this aspiring geopark possesses a diverse range of landscapes, geological formations, and unique ecosystems. This subsection provides an overview of the geographical information related to CQAG and its geodiversity.

2.1 General geographical information

CQAG includes a total of eight municipalities: Santander, Camargo, Santa Cruz de Bezana, Piélagos, Miengo, Polanco, Suances, and Santillana del Mar (Figure 1B). These municipalities together had a total population of 266,442 residents by 2023 (INE, 2023). The most densely inhabited area is in the east, where Santander and its metropolitan area are located, and population density gradually decreases towards the western part of the region. A population shift from Santander to the surrounding municipalities occurred in this zone over the past few decades, resulting in significant changes to the landscape, environment, and social dynamics of the area (CQAG, 2023).

The geopark's boundaries encompass an area of approximately 345 km^2 (269 km^2 land and 75 km^2 coastal waters), incorporating a range of coastal cliffs, beaches, and inland geological formations (CQAG, 2023). The climate in the region is Atlantic, temperate, and humid, with moderate temperatures throughout the year. Winters are mild, while summers are cool. The proximity of the Cantabrian Sea moderates temperatures and creates a high level of humidity. The region receives frequent rainfall, particularly in winter, which sustains the growth of lush vegetation and contributes to the vibrant green landscape. These climate features, combined with the region's geographical position, coastline, and rugged terrain, define the characteristics of the region (Pérez et al., 1990; Cendrero et al., 1993).

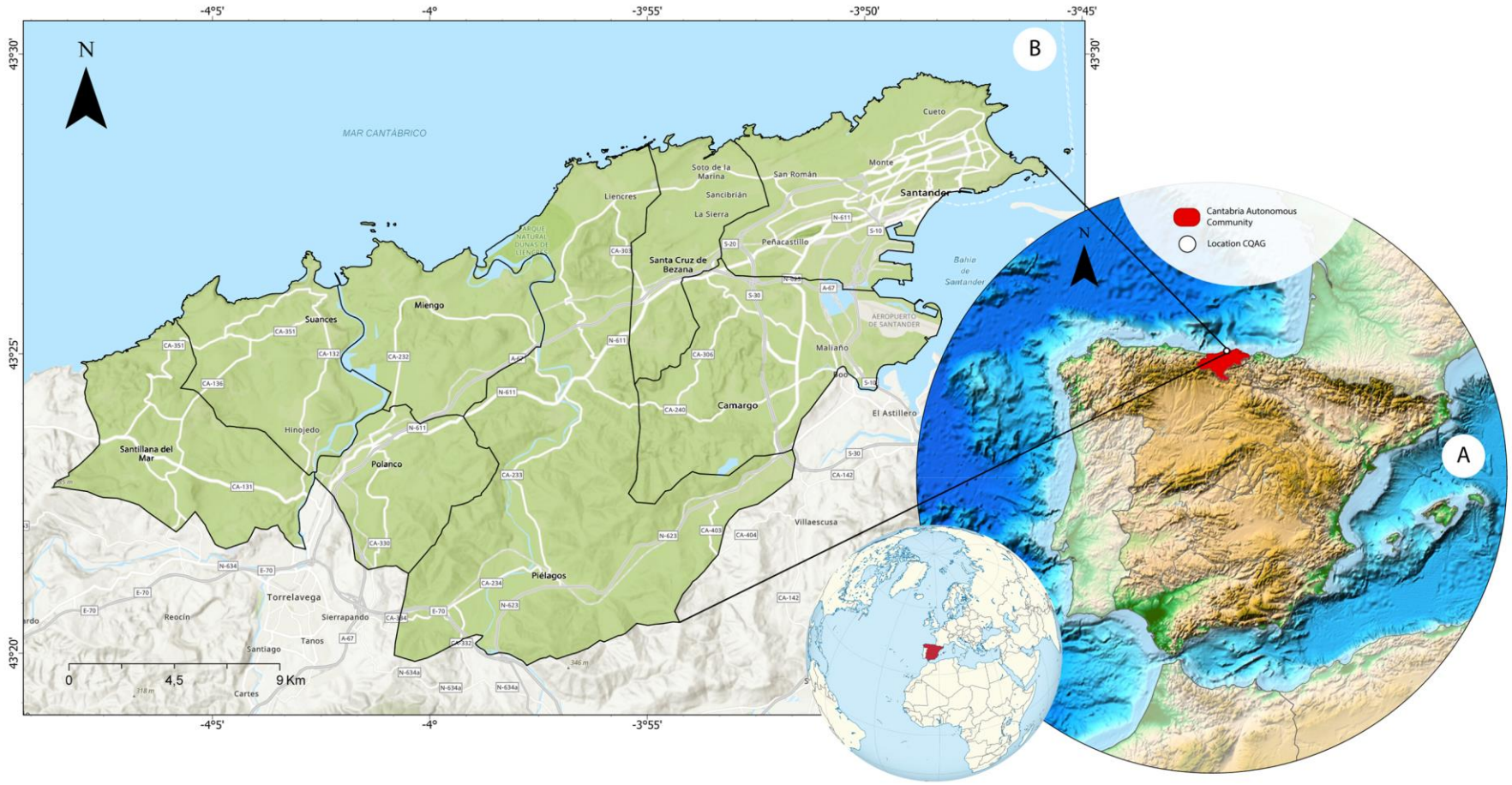

Figure 1. A) Location of the Costa Quebrada Aspiring Geopark (CQAG) in the Autonomous Community of Cantabria, Spain. B) Municipalities encompassed by CQAG.

2.2 Geodiversity

The geopark is located in the eastern section of Cantabrian Range, which corresponds to the Basque-Cantabrian basin (Figure 2). This E-W alpine structure resulted from the convergence of the Iberian and European plates during the Eocene-Miocene (Martín-Chivelet et al., 2002; Bruschi, V., & Remondo, 2019).

The area encompasses a wide range of rock units dating from the Triassic to the Paleogene, including Pleistocene and Holocene deposits (Figure 2). The sedimentation of the basal part of the sequence (Triassic succession) is predominantly siliciclastic, occurring primarily in a continental setting (coastal/ lacustrine environment). In the Lower Jurassic, sedimentation transitioned to marine environments, characterized by the deposition of extensive carbonate platform sediments, which are the predominant materials in the sequence. From this point until Lower Cretaceous (Valanginian) a stratigraphic hiatus is observed. Moving into the Upper Jurassic and Lower Cretaceous, the sedimentation was marine to continental siliciclastic. Finally, in Upper Cretaceous times, the sedimentation shifted to predominantly calcareous and marine conditions, although the carbonate platform became less continuous during this period (Ábalos, 2016; Heredia et al., 2022 and references therein).

These Mesozoic rocks were deformed during the Alpine orogeny in Cenozoic times (Heredia et al., 2022), which led to the formation of the WSW-ENE Santillana-San Román syncline, the main tectonic structure in the area. Other structures observed in the area, related to salt tectonics (diapirs) during the Mesozoic, were reactivated during this Alpine compression (Cámara, 2020), exposing Triassic and Jurassic materials.

Among the most relevant secondary processes in the previously mentioned sequence are found in the Aptian limestones, with dolomitization and mineralization of zinc, lead, and iron (Matamales-Andreu et al., 2018; CQAG, 2021). To the extent that the exploitation of minerals such as sphalerite, galena, and marcasite constituted the largest mining wealth in the province (Portero García et al., 2007).

Additionally, throughout the Mesozoic sequence, abundant and rich fossil deposits are found. Among the fossils that can be found in the Cretaceous rocks are molluscs, rudists, corals, sponges, bryozoans, sea urchins, and other organisms. In fact, in the geopark area, significant paleontological discoveries have been made, especially in two subclasses of molluscs: ammonoids and nautiloids.

Furthermore, the topography of CQAG is characterized by a blend of coastal features and inland formations. The coastline presents dramatic cliffs rising from the waters of the Cantabrian Sea, forming a striking contrast with the sandy beaches. The gradual erosion and retreat of the coastal areas have resulted in the formation of a wide range of geographic features such as inlets, coves, capes, islets, tombolos, and currently active abrasion surfaces. Additionally, ongoing sedimentation processes have contributed to the formation of diverse beach landscapes, including sand bars, spits, and dunes (Flor-Blanco et al., 2015; Cedrún, 2009; Flor & Flor-Blanco, 2014; Martínez-Cedrún et al., 2014)

The thrust fault and ridge of the Escudo de Cabuérniga create a distinct separation between more gentle slopes of the coastal zones and the rugged terrain of the interior valleys (Ureña, 1999; Figure 2). Within the park, the highest points can be found, such as El Tolío mountain, which stands at an elevation of 246 meters above sea level, and Pico Obeña, reaching 276 meters above sea level.

The landscape of the region is largely shaped by remarkable karst topography. Noteworthy features include the coastal karren of Punta del Dichoso or Robayera-Usgo, as well as significant subterranean cavities such as the renowned Altamira cave and Pendo cave. However, this distinctive topography is particularly pronounced in the municipality of Camargo, exhibiting a greater concentration of sinkholes, caves, and residual landforms. In addition, notable landforms in the area include the interfluvial hills situated in the southern region of Piélagos (CQAQ, 2023).

Chapter 3: Products and content

Recognizing the need to further enhance and showcase the geological value of the inner area of CQAG (considering that the main educational activities in the geopark are more recurrent along the coastal strip), it was decided to prioritize geoeducation actions in the southern areas of the geopark project, starting with Camargo and its surroundings, during the course of the internship. The municipality of Camargo (Figure 1B) was one of the last municipalities to CQAG, thus its collaboration and involvement with the project are slightly delayed compared to other municipalities. However, one of the activities was held in Santander. The following paragraphs describe the geographic location and geodiversity of the municipality of Camargo, given the fact that it is the main municipality for most of the designed activities. For more details of these characteristics, please refer to Annex 1, which provides a landscape analysis of the municipality of Camargo.

The municipality of Camargo is strategically positioned, bordered by Santander to the north, Santa Cruz de Bezana to the northwest, the Bay of Santander and El Astillero to the east, and Piélagos to the southwest and south (Figure 1A). With a population of 30,374 inhabitants (OACNIG, 2023), Camargo is the third most populous municipality in Cantabria, boasting a high level of economic and social dynamism (Gómez et al., 2000). Over the years, the area has undergone a socioeconomic transformation, transitioning from an agrarian-based economy to an industrial one, partly initiated with the mining industry (which included limestone and Iron exploitation) in the late 19th century, which significantly altered the landscapes of the municipality (Gómez et al., 2000; López, 2014).

The topography of Camargo is characterized by gently sloping terrain with relatively low altitudes. The highest point is Pico de Obeña, reaching an elevation of 278 meters. The area is renowned for its prominent karst landscape, featuring extensive decalcification basins surrounded by limestone formations (Muñoz et al., 2002). Flat areas in the municipality are occupied by Quaternary sediments, while extensive and thick Mesozoic materials, primarily from the Cretaceous period, form the main geological formations. Tectonic stresses and diapirism have contributed to the formation of gentle folds, fractures, and intense fracturing, shaping the distinct relief of the region (Muñoz et al., 2002).

The following describes two educational workshops implemented and two activity designs planned for future implementation in the inner municipalities of CQAG (Camargo and south of Santa Cruz de Bezana).

3.1 Educational activities

3.1.1 Programme 1 – Ecological Garden Workshop

3.1.1.1 Description and objectives

In collaboration with Camargo Municipal Environmental School, an educational workshop was carried out with children of 7 to 8 years old from Sagrada Familia School in an ecological garden within the municipality. The Environmental School typically offers activities in the ecological garden to local schools each semester, with each institute deciding on the environmental focus of the activity. However, in this case, the institute did not provide a specific focus and left the topic open to the environmental educator in charge of the activity. In addition to engaging with the garden, activities were incorporated to raise awareness about the role of geology in their surrounding environment. The workshop "Exploring what lies beneath: Discovering the world of soil," aimed to familiarize children with geological time and soil. For further details on the activities and their methodologies, please refer to Annex 2, which contains the instructional guide. Three activities were planned for this workshop.

In the first activity, a 10-meter line was created on the ground using a measuring tape, serving as a representation of the geological time scale. Volunteers among the children stepped forward and positioned themselves at specific points along the line, symbolizing significant geological events. This interactive demonstration visually illustrated the immense vastness of geological time and emphasized our position as a relatively young species in Earth's history.

In the second activity, using the Question Formulation Technique (QFT) methodology (https://rightquestion.org/what-is-the-qft/) adapted for elementary school children, students interacted with samples of limestone and soil. They asked questions about the soil following specific rules, they meant to select the two most important questions, and ultimately obtained answers to better understand the soil. The objective of the activity was to fostered curiosity, critical thinking, and an appreciation for soil as a vital resource.

In the third activity, children were encouraged to create a drawing or write a letter addressed to their "soil friend." Using mud and edible dyes, they explored different shades and textures. They were encouraged to be creative in decorating the card and asked to include a question they would like to ask the soil and a feature they liked about it. In this way, they expressed their curiosity and developed an emotional connection with the soil, promoting appreciation and care for this vital resource.

These activities aimed to spark children's interest in soil, encourage their active participation, promote critical thinking, and strengthen their emotional relationship with the environment. The first activity was implemented with the entire group of children (32 children), while the second and third activities were implemented as alternating stations. The whole group was divided into four groups, with each group rotating through different activity stations every 20 minutes.

3.1.1.2 Target group

The workshop's target group consisted of children in their second year of primary school, specifically those aged 7 to 8 years old. Based on information from various sources, including Staff (2019), Asprilia (2020), Raising Children Network Australia (2022), and the University of Montréal (2023), their key characteristics typically encompass:

1. **Cognitive Development:** They are developing more advanced cognitive skills, including improved memory, attention span, and problem-solving abilities. They can understand and follow more complex instructions.

2. **Social Development:** They are expanding their social skills and beginning to develop friendships. They are becoming more cooperative and can engage in group activities with their peers.

3. **Physical Development:** They have better control over their fine motor skills, enabling them to write more neatly and manipulate objects with greater precision. They also enjoy pushing their physical boundaries and aspire to cultivate more intricate moving skills.

4. **Curiosity and Exploration:** They are curious learners, eager to explore and discover new things. They have a natural sense of wonder and are open to new experiences and ideas.

5. **Developing Independence:** They are gradually becoming more independent from parents and self-reliant. They are learning to take on more responsibilities and make decisions on their own, within the boundaries set by adults.

6. **Concrete Thinking:** They predominantly engage in concrete thinking rather than abstract reasoning. They benefit from hands-on experiences, visual aids, and concrete examples to understand concepts.

7. **Short Attention Span:** Their attention span is still developing, and they may find it challenging to sustain focus for extended periods. Activities should be interactive, engaging, and varied to maintain their interest.

8. **Imaginative and Creative:** They have vivid imaginations and enjoy imaginative play, storytelling, and creative activities. They can think outside the box and appreciate activities that allow them to express their creativity.

It is important to note that these characteristics can vary among individuals, as children develop at their own pace.

3.1.1.3 Implementation process and learning outcomes

The educational workshop faced some challenges during implementation, which impacted the overall flow and effectiveness of the activities. Despite these difficulties, efforts were made to adapt and engage the children as best as possible.

During the implementation of the first activity, it became evident that the allocated space for the timeline representing geological time was insufficient (Figure 3). Initially, only 10 meters were planned for the activity due to the limited length of the garden. Unfortunately, this proved to be inadequate. As a result, when children volunteered to represent the most recent geological events, they became congested within the last meter. This overcrowding made it challenging for all the children to visualize and understand the timing of these events. Consequently, their grasp of the vastness of geological time was somewhat hindered. To enhance the impact and facilitate a clearer understanding, it is recommended to allocate a larger space of approximately 50 to 100 meters for this kind of activity. With a more expansive area, a more powerful comparison can be made, such as between the

appearance of the human species and the entirety of Earth's history. Additionally, it would be beneficial to label each meter along the line created with the measuring tape. This labelling would provide children with a constant reference point, allowing them to locate specific events and more effectively engage with the question of when they believe those events occurred. It was learned that considering these implementation details is crucial for achieving optimal outcomes in such activities.

In the second activity, where children were meant to write questions about soil, several difficulties arose. Some of the children did not show interest in writing, and the absence of tables or stable writing surfaces posed an additional difficulty. Nevertheless, it was encouraging to see that they were focused on digging and exploring the ground, which showed their enthusiasm for the activity (Figure 4). While some children may not have actively followed all the provided rules for the activity, their engagement with the hands-on exploration was a positive aspect of their participation. However, the distraction and lack of focus in following the guidelines hindered the full development of the planned activity, including the selection of questions for further exploration.

Figure 2. Children engaging in Activity 1 of the Ecological Garden Workshop.

Figure 3. Children enthusiastically exploring and digging the ground during Activity 2 of the Ecological Garden Workshop.

Upon realizing that the activity was not effectively engaging the first group and considering the limited time available for each group, adjustments were made for the subsequent groups. The revised approach involved focusing the activity on asking questions related to the children's immediate surroundings while the children explored the soil with shovels and examined rock samples. It should be noted that conducting the QFT outdoors was not ideal for the target group, as the outdoor environment tends to easily distract the children, resulting in shorter attention spans. Despite the challenges faced, it is important to highlight that the children's curiosity about their surroundings was sparked as some of them expressed a greater inclination to ask questions. While the QFT activity did not unfold as originally intended, the experience still succeeded in generating interest and fostering a hands-on approach to learning.

Initially, for the third activity, there was a plan to differentiate the letters between the groups that had already gone through the second activity and those who had not. The groups were named based on different plant parts, such as roots, leaves, flowers, or fruits. The purpose was to assess whether the second activity had been effective in arousing the children's curiosity about the soil and determining if

they had successfully connected with it. Unfortunately, it was not possible to differentiate the letters as they became mixed up at the end of the activity.

To address this issue, one possible strategy could have been to provide each group with a specific color of cardstock that would characterize their letters. For example, the group focusing on leaves could have been given green cardstock, while the group focusing on fruits could have received orange cardstock. This would have facilitated the differentiation and assessment of the impact of the second activity on each group. Another difficulty encountered during the implementation was the abstract nature of questioning the soil, which proved to be challenging for the children. As a result, they did not ask questions directly to the soil. Instead, they were encouraged to express gratitude through a letter, emphasizing a benefit they knew the soil provided (Figure 5). This approach aimed to foster an emotional connection with the soil and highlight its importance. Overall, the implementation of the activity faced challenges, such as the mixing of letters and the abstract nature of questioning the soil. However, these difficulties provided important insights for future improvements in guiding and structuring the activity.

Figure 4. Children engaging in a hands-on activity, expressing their gratitude to the soil through letter writing during Activity 3.

Despite encountering implementation challenges, the workshop successfully instilled curiosity among the children and encouraged them to question their surroundings. However, it is evident that there were shortcomings in the execution due to inadequate planning, failure to anticipate challenges, and insufficient understanding of the target group. The children's high activity levels, difficulty in following instructions, and time constraints posed obstacles to conducting the activities as intended. One specific issue arose during the second activity when it became apparent that conducting it outdoors was not suitable. To improve the workshop experience, it would have been beneficial to provide more focused guidance and implement additional strategies to address the children's energy levels and attention spans. By doing so, better comprehension and engagement could have been achieved throughout the activities. In Annex 3 can be found additional photographs, evidence of the planned activities and the resulting letters from the children.

3.1.2 Programme 2 – "PequeIngeniería" Workshop

3.1.2.1 Description and objectives

An educational workshop was held during the "PequeIngeniería" week in the city of Santander. This week is part of a project initiated by the School of Civil Engineering at the University of Cantabria, with the main objective of promoting scientific and technical knowledge among the general population, especially targeting the younger generation, in order to inspire interest in civil engineering. To achieve this goal, various workshops are conducted, and educational materials are created.

CQAG participated by offering a workshop titled "A Journey through Geological Time" (Annex 4) with the aim of familiarizing children with the concept of geological time and emphasizing the significance of soil as a non-renewable resource. This workshop represents an evolution of the activity previously described in the first phase of the Ecological Garden Workshop. With the purpose of refining the original idea and leveraging the knowledge gained during the first activity in the Ecological Garden, children have been provided with the opportunity to depict a series of events that have made their mark in Earth's history. Moreover, teamwork collaboration is encouraged, enabling them to collectively organize and place these events on a timeline drawn on the ground. Through this role-playing game, they would grasp the relative brevity of human existence compared to the geological history of the planet. The workshop also gave the opportunity to highlight that once soil is covered by infrastructure or buildings, it cannot be recovered within the lifetime of each child.

3.1.2.2 Target group

The "PequeIngeniería" workshop was designed for children between the ages of 7 to 13, representing a broad spectrum of young learners with differing cognitive and physical developmental stages. The distinct attributes of the 7 to 8-year-olds have been detailed in the preceding subsection, while those of the 12 to 13-year-olds are expounded upon in the subsequent section titled "Target Group" found in the "Didactic Guide" title. Consequently, this section will provide a brief overview of the key traits distinguishing the 9 to 11-year-old participants, drawing from insights gathered from references such as Stewart (2013), McLeod (2023), Nortje (2023), and NCATSU (2023).

1. **Increased Cognitive Abilities:** Participants in this age group demonstrate enhanced cognitive capabilities, including improved problem-solving skills, abstract thinking, and the ability to grasp more complex concepts. Their curiosity and eagerness to explore new ideas make them receptive to hands-on learning experiences.

2. **Growing Independence:** Children aged 9 to 11 are gradually gaining independence and self-reliance. They are better equipped to follow instructions, work on tasks with less direct supervision, and take on a more active role in collaborative projects.

3. **Refined Motor Skills:** At this stage, participants' motor skills are notably improved, allowing them to engage in more intricate and detailed activities. They are capable of handling smaller tools and materials with greater precision.

4. **Heightened Social Interaction:** The 9 to 11-year-olds increasingly enjoy peer interactions and group dynamics. They are able to engage in more complex teamwork, sharing ideas, negotiating tasks, and collaborating effectively to achieve common goals.

5. **Expanding Interests:** Participants in this age range tend to exhibit a broader range of interests. They are curious about various fields and are more receptive to exploring different interests, fostering a well-rounded and diverse learning experience.

6. **Attention Span and Focus:** While their attention spans are extending, maintaining engagement remains important. Activities in the workshop should be designed to maintain their focus and interest.

7. **Concrete and Abstract Learning:** Children aged 9 to 11 can understand both concrete and abstract concepts. Abstract thinking capacity becomes particularly pronounced at the age of 11, however, children at this age group still have difficulties with this ability. They possess the capability to establish connections between real-world experiences and theoretical concepts, allowing for deeper exploration of more complex principles.

In the case of this workshop, it is important to consider that parents have enrolled their children. This suggests a level of parental support and interest in their child's educational and developmental experiences. The parents recognize the importance of exposing their children to engineering-related activities and encourage their participation in this week-long celebration "PequeIngeniería".

3.1.2.3 Implementation process and learning outcomes

The educational workshop began with an introductory session (Figure 6) that encouraged children to ponder the origins of the nature around them. Subsequently, we ignited their curiosity by posing the question of our planet's "birthday" – how old they believed it to be. Once armed with the correct answer, we engaged them in a mental exercise: to envision the vastness of Earth's history compressed into a timeline on the ground (10 meters), marked at each meter (Figure 7).

Figure 5. Introductory session for "A Journey through Geological Time" Workshop during the PequeIngeniería week celebration.

Figure 6. A visual representation of Earth's age depicted by a 10-meter line on the floor, with each meter demarcated to symbolize the passage of time. This image captures the moment after groups had positioned their respective cards on the floor.

Arranged in pairs, we presented the activity that would unfold. We handed out cards, each depicting a pivotal event in the planet's history. Each group immersed themselves in reflection over where their event should be placed on the timeline. Subsequently, we encouraged communication among the groups to collaboratively adjust the placements, relying on shared discussions and reasoning (Figure 8).

Figure 7. Promotion of inter-group interaction and collaboration, fostering discussions and potential adjustments in the placement of cards as needed.

The conversations among the groups enriched the experience. After socializing, each team reached a consensus on the order and locations of the events. Collectively, with the guidance of instructors, we meticulously verified the order, ensuring they were arranged chronologically, from the oldest occurrences to the most recent.

We continued the exploration, revisiting the timeline to assess the accuracy of event placements. We emphasized the relatively recent history of humanity compared to Earth's vast timescale. At this juncture, we underscored the crucial role of soil, the foundation of our structures, as a non-renewable resource. We highlighted that soil, derived from geological processes spanning millennia, cannot regenerate within a single human lifetime. We emphasized that soil, a product of geological processes spanning millennia, cannot regenerate within a single human lifetime. Impressively, we conveyed that the formation of a mere centimetre of soil could span up to a millennium.

Upon analysing the activity's implementation, we identified opportunities for significant enhancements. We considered that a more extensive timeline, perhaps spanning 50 or 100 metres, could amplify the perception of geological time (as previously mentioned in the Ecological Garden workshop). However, this would hinge on available space. Furthermore, we explored alternatives to sustain children's

interest, such as providing objects related to events (e.g., presenting a toy dinosaur for the event of dinosaurs' appearance) or allowing groups to create more tangible visual representations (whether they draw them, construct them using provided materials, or even dress up as elements from the events).

As an improvement, we also contemplated connecting historical human events to the timeline, aiming to capture children's attention and interest. The process of forming groups and encouraging discussions proved highly positive, keeping the children active and engaged throughout.

Even though the interaction among children of different ages was positive during the activity, another improvement that could be applied is not to have made the age range of the audience, particularly children, so wide-ranging. For instance, children aged 7 to 9 have significantly different needs and abilities compared to children aged 10 to 14. For example, it was evident and logical that the older children in the group had a cognitive advantage over the younger ones, who had a less developed abstraction of time. In the case of an audience focused on adults from various age ranges in general, perhaps in this scenario, there wouldn't be much issue in combining different adult age groups in an activity. However, when dealing with minors, where skills and abilities can vary significantly, it's better to consider narrowing down the age range of the target audience for children. This educational activity metamorphosed into a valuable experience that not only immersed the children in the planet's history but also left them with an understanding of the significance of geological time and the resource of soil in society.

3.2 Educational proposals

The designed educational proposals consisted of two components: one focused on informal education, involving the development of contents for the interpretation of a georoute, and the other aimed at formal education, entailing the creation of a didactic guide for teachers, which includes a field trip tailored to the school curriculum. The selection of sites for the georoute (some of which were later adapted for the student's field trip) was carried out through a preliminary landscape analysis, consultations with local experts, and a review of potential sites in the literature. Although the municipality of Camargo does not offer exceptional conditions for observing geological elements, partly due to abundant vegetation hindering visibility, four geosites of relevance (one with regional significance and the rest with local relevance) are included in the CQAG's inventory. One of the criteria for selecting educational sites was their proximity to the large polje of the Escobedo Valley, where more potential

sites of geological, biological, and cultural interest were clustered. A qualitative assessment (Annex 5) of these places was conducted to assess their interpretative and educational potential, following the methodology of Brilha (2016). The aim was to identify the sites that establish connections with various educational content areas such as history, geography, and/or biology, and to ensure that the sites were easily accessible and safe for visitors.

Additionally, the aesthetic value of the landscape was considered in the selection process, and priority was given to sites that were already frequently visited by tourists. The current management and maintenance of the sites were also taken into account to ensure a pleasant experience for visitors. A significant criterion was to select sites that would illustrate the relationships between biodiversity, geodiversity, and/or society. Proximity between sites was sought and sites that could be grouped together to create an engaging and cohesive narrative for visitors. For more detailed information on the inclusion or exclusion of specific places from the georoute, please refer to Annex 5.

3.2.1 Proposal 1 – Interpretative contents of a georoute

3.2.1.1 Introduction and objectives

As previously mentioned, in order to highlight the value of CQAG's inner areas, educational initiatives were planned to be conducted in the municipalities within this region. Through consultations with local experts and fieldwork conducted in collaboration with Viola Bruschi and Dario Ferrari in the municipality of Camargo, we observed a captivating karst landscape located in the town of Escobedo. This area features a polje, a unique landform, and a viewpoint situated on a crag. This viewpoint offers a panoramic view of the entire karstic valley, spanning across the south of Santa Cruz de Bezana municipality and the northwest of Camargo municipality. Recognizing the potential of this location, it was proposed to develop a georoute in this locality. A georoute, also known as a geotrail, is a tourism product that combines the knowledge, preservation, and interpretation of a region's geological heritage (Martínez-Graña et al., 2017). It serves as a geotourism module that can be found within or outside geoparks (Stolz & Megerle, 2022). According to the Geological Society of Australia website, by taking visitors on a journey through an area's geology and landscape, a georoute delivers engaging, educational, and enjoyable geotourism experiences. It provides opportunities for visitor engagement, learning, and appreciation by showcasing the geological features, processes, and history that shape the natural environment.

The georoute is located in the southern tip of the Santa Cruz de Bezana municipality and the western part of the Camargo municipality (Figure 9), encompassing the town of Escobedo. The primary objectives of this georoute are to provide tourists with a comprehensive understanding of the significance of limestone rock and the karstification process in shaping various aspects of the landscape. Additionally, it aims to raise awareness about the importance of preserving encinar ecosystems and to highlight the negative social and economic impacts associated with water extraction from aquifers. The methodology used for developing the contents of the georoute is based on the approach outlined in Stolz & Megerle (2022), which draws upon Megerle's work in 2008 (Figure 6). The initial steps of the methodology, including landscape analysis (Annex 1), defining the target audience and mediation subjects, and establishing mediation goals and content development for the georoute, have been implemented so far. The implementation of the remaining steps in the methodology is planned for future stages.

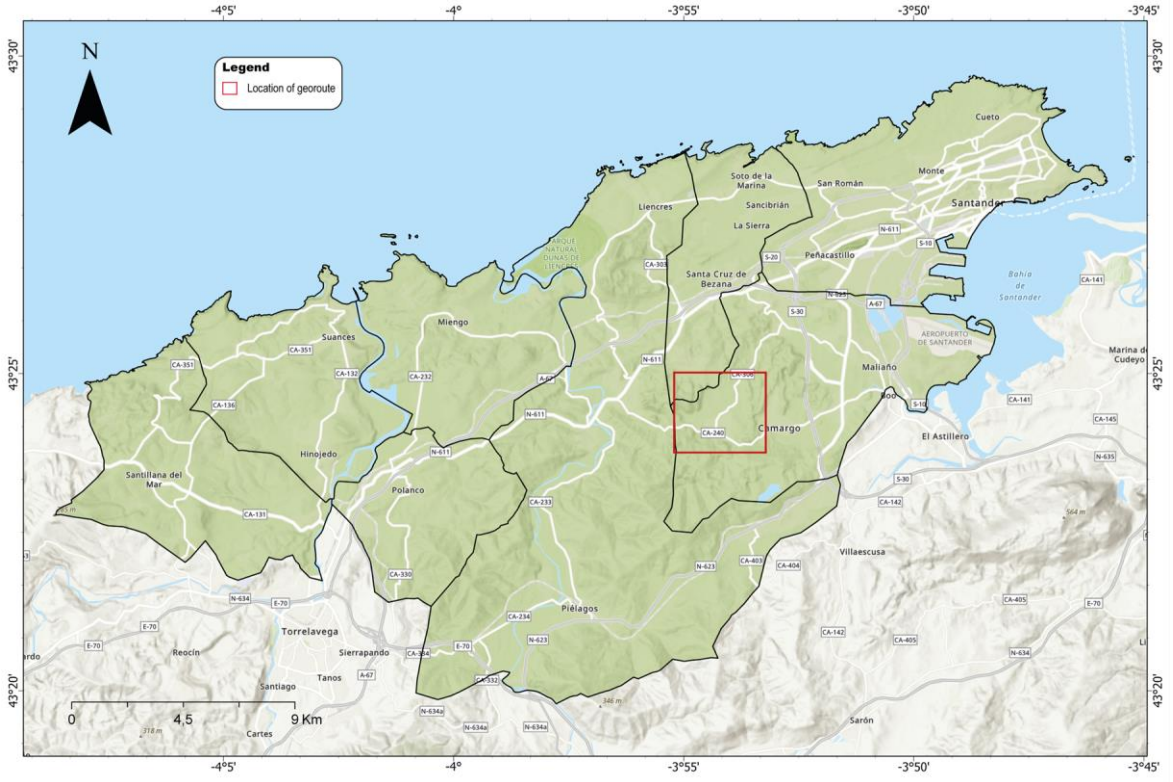

Figure 8. Georoute location within the CQAG area.

3.2.1.2 Target group

The target group for this georoute consists of nature enthusiasts and casual hikers who enjoy outdoor activities and have an interest in exploring natural landscapes. They are likely to be physically active individuals who appreciate the beauty and tranquillity of nature.

Key Characteristics:

1. **Age:** Adults aged 15-70, although the route can be suitable for a wider range of age groups.
2. **Interests:** Nature, hiking, outdoor activities, geology, scenic viewpoints.
3. **Physical Fitness Level:** Moderate fitness level, as the route involves some rocky terrain and requires a moderate level of physical exertion.
4. **Knowledge Level:** A mix of individuals with basic to moderate knowledge and curiosity about nature and the local landscape.
5. **Motivation:** They seek a combination of exercise, natural beauty, and educational opportunities to learn about the geological features of the area.
6. **Group Size:** Can be individuals, couples, families, or small groups of friends.

3.2.1.3 Mediation subject

The mediation subject chosen for the georoute in the karstic massif of Peñas Negras aims to present an engaging narrative by personifying the mountain as a resilient entity. This approach allows to explore the various challenges and transformations the massif has faced, including due to climate change, the invasion of eucalyptus trees, and contamination of its aquifers due to quarrying activities. By highlighting the mountain's struggles and emphasizing its ability to withstand adversity, we seek to raise awareness about the significance of preserving Peñas Negras and the valuable connections it holds with the surrounding environment. Furthermore, there is a possibility to extend the georoute to include the Cantera de Bilbao and Pozón de la Ruperta sites, allowing for a seamless continuation that further explores subjects touched upon in the Peñas Negras geotrail.

Key Characteristics:

1. **Personification:** By attributing human qualities to the mountain, such as resilience and endurance, we aim to establish an emotional connection with the visitors. This approach encourages them to view Peñas Negras as more than just a geological formation but as a living entity deserving of appreciation and protection.

2. **Interconnectedness:** The mediation subject focuses on exploring the intricate relationships between Peñas Negras's limestone rock, the oak forest, and the aquifers within. It highlights how disruptions to one aspect can have cascading effects on the entire ecosystem, emphasizing the need for a holistic preservation approach.

3. **Environmental Challenges:** The subject addresses specific challenges faced by Peñas Negras, including adaptation of the Encinar ecosystem to the change of climate conditions throughout millions of years and the invasion of eucalyptus trees. By highlighting these challenges, visitors gain a deeper understanding of the complex dynamics at play and the importance of mitigating their effects to ensure the mountain's long-term viability.

4. **Water Pumping and Quarrying:** The mediation subject also focuses on the negative consequences of excessive water pumping from aquifers and the contamination resulting from quarrying activities. It underscores the potential threats to the stability of Peñas Negras and the local community, linking these issues to the mountain's story and fostering a sense of responsibility towards sustainable resource management.

5. **Educational Narrative:** The subject is presented as a cohesive and engaging narrative, guiding visitors through different chapters that unveil the mountain's story. This approach helps to maintain visitor interest and facilitate the understanding of complex concepts related to geology, ecology, and human impact.

By employing this mediation subject, the georoute aims to create an immersive and educational experience that encourages visitors to appreciate the intrinsic value of Peñas Negras and become advocates for its preservation. The narrative approach, coupled with the exploration of interconnected relationships and the challenges faced by the mountain, provides a comprehensive understanding of the significance of this unique ecosystem and the need to protect it. The mediation goals and contents of the georoute in Spanish, with other details can be found in Annex 6.

3.2.1.4 Contents

The following georoute offers the possibility of making an autonomous visit to the site, without the need of a guide, taking advantage of a virtual medium that will allow tourists or visitors to tour the sites with their cell phone in hand and complement what they see in situ with material provided virtually. This subsection focuses exclusively on the contents of the georoute, without including visual design or the way in which the information will be accompanied. Figure 10 shows the map of the georoute, with two proposed routes.

The first route, marked in red on the map, is limited to the Peñas Negras area and is exclusively on foot. This option offers a pleasant experience of the natural environment of Peñas Negras. Visitors will have the opportunity to explore highlights of the landscape and learn about one of the most relevant geological phenomena in the area.

For those who want a longer and more enriching experience, we suggest the possibility of extending the tour, marked in yellow on the map. This extension incorporates two additional stops that allow to go deeper into topics related to what was seen on the Peñas Negras route and to explore other specific aspects of the landscape.

Route 1 (red color):

Starting point: "La Jaya" bus stop, Barrio de la Yasa, Maoño, Santa Cruz de Bezana.

Total distance: 3 km

Altitude: 207 m

Elevation gain: 132.5 m

Suitable for baby carts: No

Difficulty: Easy

Duration: 50 to 60 minutes

Public transport:

Valdecilla Norte (Santander)- La Jaya (Santa Cruz de Bezana): Direct bus, ALSA- S5 Std-Mao, however, there are two schedules, one in the morning and one in the afternoon.

Route 2 (extension route 1 - red and yellow color):

Starting point: "La Jaya" bus stop, Barrio de la Yasa, Maoño, Santa Cruz de Bezana.

Total distance: 6.2 km

Difficulty: Easy

Other transport observations: After completing the first route, there are two possibilities to continue and reach the tenth stop: if you have a car, you can choose to drive; otherwise, the option would be to walk 40 minutes, as there is no direct public transport connecting both places.

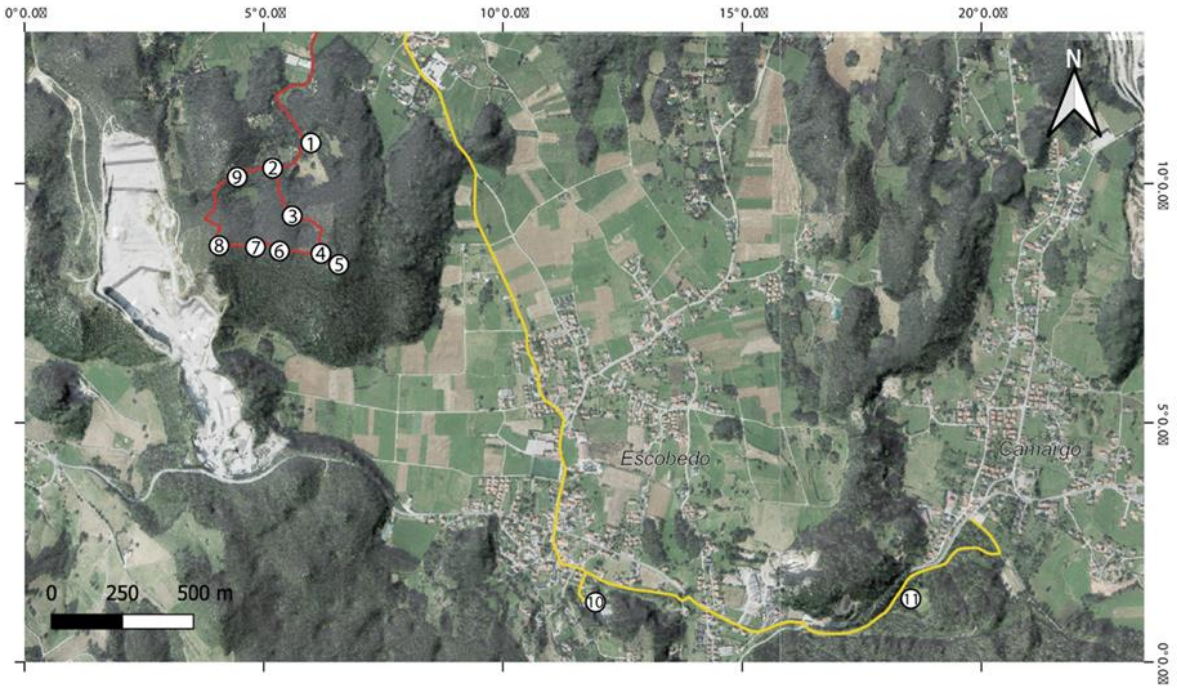

Figure 9. Georoute map showing stops in the two options: short trail (red) and long trail (yellow).

INTRODUCTION TO THE ROUTE:

Key idea:

Introduce and personify the Peñas Negras mountains as a resilient mountain.

Emotional objective:

Seeking to raise curiosity, empathy, appreciation in the visitor.

Defying appearances: The hidden richness of Peñas Negras

"In the Peñas Negras mountain, there is much more than meets the eye. As human beings, we sometimes judge people based solely on their external appearance, without taking the time to get to know their inner selves. Sometimes the same thing happens to us with the nature that surrounds us. Just as with people, only when we take the time to get to know their inner personality, we can fully appreciate the jewel and the unique value they possess.

In this georoute we invite you to venture into the Peñas Negras Mountains to discover their hidden richness and the challenges they have faced. As you walk along the trail you will be surprised to discover a beauty that goes beyond the superficial.

Discover the story of resilience it has to tell you, look closely at the details that reveal its personality and connect with the deep essence of nature. Enjoy your journey of discovery!"

FIRST STOP

Key idea:

Dolines are funnel-like geological formations that originate from the dissolution of rocks, in this context in limestone rocks.

Learning Objective:

To recognize a doline as a funnel-like geological formation, understanding its origin from the dissolution of rocks, particularly in limestone rocks.

The Dolina: A natural funnel in the landscape

Look carefully at the terrain... do you notice that circular formation sunk into the ground? This structure is known as a doline and reveals the dissolution of rocks at depth. In the interior of the mountain, limestone rocks are found, composed mainly of calcium carbonate. These highly soluble rocks are the perfect target for the amazing geological process that occurs here, known as "karstification".

The limestone rocks dissolve over time, creating subway cavities in the earth - it's as if the mountain has its own secret world underground! But the magic doesn't end there, when the cavity reaches a certain point, the roof collapses and voila, a sinkhole is born!

Imagine a giant funnel in the earth, like the one we use in the kitchen to pour liquids. The doline is just that, but on an amazing scale. It acts as a sort of natural catcher, channelling water and other elements underground. As you look closer to the center of the doline, you'll notice how the earth descends in a conical shape, like the narrow tube of the funnel.

Continue the georoute to discover more about the fascinating qualities of the wonderful interior of Peñas Negras."

SECOND STOP

Key idea:

Holm oak and limestone rock have an intimate relationship, where the presence of limestone rock influenced the formation and development of the holm oak woodland ecosystem.

Learning Objective:

To understand and appreciate the close relationship between the holm oak woodland and limestone rock, recognizing its importance and understanding how limestone rock influences the sustainability of the holm oak woodland ecosystem.

El Encinar de Peñas Negras: Nature's Resilience in a Changing Environment

In this unique place, the surface beauty emerges from the limestone rocks, giving life to a forest ecosystem dominated by evergreen oak trees known as *Quercus ilex*.

The presence of these forests in this region has always intrigued naturalists who have visited them in the past, as they persist in an environment so different from its typical Mediterranean climate (warm and arid). Cantabria, with its abundant rainfall and humidity, defies the rules.

The holm oak forest has a special connection to the past... Approximately 2 million years ago the climate in the Cantabria region was arid and resembled the conditions in the interior of the Iberian Peninsula. As the climate evolved towards cooler and wetter conditions, plant species had to adapt to survive. It is believed that holm oaks (*Quercus ilex*) and other species sought refuge in drier and warmer enclaves. Holm oaks took advantage of the favourable conditions offered by limestone rocks. Their ability to filter water and limit soil formation mimicked the drier and warmer conditions of the past. This is how the limestone rock became a crucial ally for the holm oak forest. In addition, this enigma invites us to reflect on how nature finds ingenious solutions to survive.

Enter Peñas Negras and contemplate the living testimony of natural resilience. Explore the wonders of this oak forest and be inspired by its ability to adapt, resist, and flourish in a constantly changing environment. Prepare to witness the tenacity and beauty that nature has to offer!

THIRD STOP

Key idea:

Aquifers play an essential role in the ecosystem and in sustaining the local territory by maintaining the water balance.

Learning Objective:

To understand the crucial importance of aquifers for the well-being and sustainability of the territory, recognizing their intimate relationship with the surface waters that supply water to the population.

In the Depths of Peñas Negras: An Underground Treasure

Deep inside Peñas Negras hides a real treasure: an aquifer! Right under your feet at this moment, there is a natural reservoir of water. But how is it possible that there is water under the ground? The subway rocks here are very soluble, and water, over thousands or even millions of years, has created amazing subway cavities in the limestone rock. Imagine the force of water moulding these wonders beneath our feet.

As water flows and seeps through the cracks and pores in the limestone rock, groundwater accumulates, making up this valuable aquifer.

We can think of the subway cavities of the aquifer in limestone rock regions as the pipes in a house, allowing water to move and be stored in different locations. These groundwaters are intimately connected to the coastal fluvial ecosystems of the Pas River and the Ría de Boo-Bahía de Santander, as they are what maintain the flow of these rivers.

In fact, the Pas River is the main source of water supply for the city of Santander, supplying the city's urban water reservoirs.

This is how we see that surface water is closely connected to groundwater, which represents 22% of the total freshwater on the planet and constitutes the largest accessible freshwater reserve. Aquifers are therefore a treasure for our planet.

But their importance goes beyond that, since everything that affects an aquifer has repercussions on the hydrological cycle as a whole. Moreover, aquifers are a long-term reserve that guarantees water supply during emergencies, droughts, and climate change.

Caring for and protecting aquifers is essential to maintain our freshwater supply and preserve the aquatic ecosystems that depend on them.

FOURTH STOP

Key idea:

Interesting facts about plants and fruits that flourish at Peñas Negras, appreciating their diversity and the interesting stories behind them.

Learning objective:

Appreciate the diversity of the fruits/plants that occur at Peñas Negras and learn the fascinating stories behind them.

Emotional objective:

To awaken positive emotions, such as awe, wonder, and curiosity, by exploring the wonders of the plants at Peñas Negras, creating an emotional connection with nature and the environment.

The secret of the flavour of the best Iberian hams!

Acorns, the fruit of the holm oak and other Quercus species, are the preferred food of Iberian pigs and are the key to the exceptional flavour of 100% Iberian acorn-fed ham. This healthy diet enriches the meat with unsaturated fatty acids, making it a heart-healthy option. The pigs feed on acorns during the fattening period, gaining up to 50 kilos in two months thanks to the nutritional properties of this delicacy.

Beware of the strawberry tree!

Its irresistible berries have a high alcohol content, so taking just one of them could make you feel the effects of its intoxicating secret. In fact, hunters hoped they would be eaten by birds to hinder their flight and make it easier to capture them. A fruit that captivates both birds and brave adventurers.

Hawthorn: An Oasis of Protection and Life

Hawthorn bushes not only provide tasty fruit, but also offer shelter and protection to a variety of bird species and small mammals. Their dense, thorny shrubs (hence the name) are ideal for nesting and shelter from predators, making Hawthorn a valuable ecosystem in its own right.

Fruits for the brave

Although the blue fruits of the blackthorn are edible, their tart and astringent flavour makes them best suited for use in beverages and culinary preparations, such as liqueurs, jams and desserts. Enthusiasts of strong, bold flavours will find sloe an exciting culinary challenge.

The Bramble in Action: Gravity Defying Thrushes

During spring, the blackberry displays a fascinating phenomenon. Its shoots, which are young, flexible shoots, operate like scouts, actively searching for the right support for their growth. Although the movement is imperceptible to the naked eye, the shoots can grow up to five centimetres a day, demonstrating a remarkable capacity for adaptation and expansion.

Ingredient of the first cola drink

Before the appearance of modern commercial colas, a refreshing drink was made from the roots of sarsaparilla, sugar, honey and water and was widely consumed in Europe and America. Sarsaparilla was used in the world's first cola drink.

FIFTH STOP

Key idea:

This landscape defies understanding due to its origin in karst relief, being considered one of the most controversial.

Learning objective:

To appreciate the amazing uniqueness of the Escobedo valley as a karst relief and to learn about the controversy surrounding its origin.

Enjoy a privileged panoramic view of the Escobedo valley from this point, admiring the majestic neighbouring mountains of Peñas Negras! This landscape is known as "polje" by scientists, a word meaning "field" or "terrain" in Slovenian. Its exact origin remains a mystery to experts and it is considered the most enigmatic karst landscape in the temperate regions.

One theory proposes that this valley was formed from the gradual union of dolines, creating a depression as vast as the astonishing landscape in front of you. Imagine this valley as a gigantic doline, the progressive collapse of a cave ceiling of epic proportions. Who could have imagined the existence of subway cavities of such magnitude?

However, the Peñas Negras mountain proved its resistance and strength by not collapsing and avoiding becoming part of the valley plain. This beautiful mountain shows us its durability and tenacity in the face of geological changes. Admire the grandeur of nature in this magnificent place!

SIXTH STOP

Key idea:

Highlight the dissolution capacity of limestone rock. The formation of limestone rock.

Learning objective:

To explain the solubility of limestone rock and its formation in the area.

Emotional objective:

To provoke a positive emotional reaction in the visitor, awakening his curiosity and wonder at the geological processes.

The limestone rock fragments in front of you are a direct window to the interior of Peñas Negras, and go beyond simple pieces of stone. Immerse yourself in one of the fascinating characteristics of the interior of Peñas Negras: its ability to dissolve.

Experiment with lemon juice and limestone:

Conduct your own experiment! Squeeze lemon juice on the limestone rock and see how it reacts. You will see how the citric acid in the lemon triggers a chemical reaction. The limestone rock will slowly dissolve, revealing its amazing ability to react to acidic substances.

Recommendations: For a more noticeable reaction, look for a portion of limestone rock that is less weathered, with no light grey or yellowish tones. You can also rub two pieces of limestone rock together to expose a fresh surface before squeezing the lemon. Be encouraged to try different sides and rock fragments!

Why does limestone rock dissolve?

Limestone rock is composed primarily of calcium carbonate. Its unique chemical nature allows it to dissolve in the presence of acids such as citric acid. This slow dissolution over time is the key to the formation of caves and other fascinating geological forms that you can find in this area. In nature, this phenomenon can take millions of years!

How did limestone rocks form?

Limestone rocks are testimony to a past where the place you walk on was covered by an ocean approximately 115 million years ago, not the Atlantic as it is today. The distribution of continents and oceans on the planet was different from today. They were formed on the seafloor as corals and marine animals with shells accumulate over time, becoming hard rock under their own weight. This is why you can sometimes find fossils in limestone rocks, the remains of plants and animals that lived long ago. We encourage you to explore carefully through the limestone rubble in search of amazing fossils - there's a story in every fragment!

SEVENTH STOP

Key idea:

The eucalyptus plantation was a threat to the Peñas Negras ecosystem.

Learning objective:

To understand that extensive eucalyptus plantations are detrimental to the balance of the ecosystem, displacing native species and affecting biodiversity.

Emotional objective:

To arouse frustration and then hope for the bush by comparing the eucalyptus problem to a cancerous disease.

Skin cancer is a condition in which abnormal cells grow in human skin tissues. Now, imagine that the vegetation cover of the Peñas Negras rock massif is like the skin of this place. In this case, the Peñas Negras massif suffered a similar disease when eucalyptus plantations were introduced, trees that originated in Australia and can be considered "abnormal" in this region.

You may ask, why were non-native trees planted in Cantabria? The answer is simple: eucalyptus is a profitable crop used for the production of paper and cardboard, among other industrial products. Its rapid growth and capacity to generate timber make it economically attractive. However, this decision has consequences for local ecosystems.

When the native trees were cut down to make way for eucalyptus, the mixed forest characteristic of the area was thrown out of balance. Massive eucalyptus plantations can be considered invasive species because they compete with native species, release chemicals that inhibit the growth of other plants, and their fruits are not attractive to local fauna, driving them away from the forest.

Fortunately, this disease was controlled in time. The Fundación Naturaleza y el Hombre intervened to progressively "extirpate" the eucalyptus trees and replace them with native vegetation, although some eucalyptus trees still remain. Peñas Negras once again demonstrated its resistance and resilience.

Remember that, by visiting this place, you are witnessing nature's incredible capacity to recover and renew itself.

EIGHTH STOP

Key Idea:

Limestone is a valuable resource for both biodiversity and modern society, but it is essential to consider its environmental impact, especially on aquifers.

Learning Objective:

Raise awareness about the role of limestone usage in our society and highlight its negative impact on aquifers.

Behavioural Objective:

Encourage conscious actions in everyday life that can affect aquifers.

Examining Limestone Exploitation: Wealth or Environmental Disaster?

The quarry visible at this point reveals the inner workings of Peñas Negras, exposing limestone. This material has not only proven to be of great value to biodiversity but also to modern society, offering a wide range of uses and services (construction, chemicals, and agriculture).

A Charmed Rock: Strength, Durability, and Elegance

The limestone from this region is not just an ordinary stone. It is highly regarded nationwide for its strength, durability, and elegant rustic aesthetic. It is popularly known as the "Stone of Escobedo" and has left its mark on impressive constructions like the Casa de Correos Institute, the Magdalena Palace, and the Bank of Spain in the city of Santander.

A Delicate Balance: Let's Care for Our Natural Environment

While limestone extraction has brought social benefits, it is crucial to consider its environmental impact. Extraction must follow environmentally sound practices to prevent pollutants from being released into the soil or groundwater and subsequently migrating to our precious aquifers, including Peñas Negras. This could affect the entire water system of the region and endanger the wildlife that depends on it, including ourselves. It is a delicate natural balance.

The Human Footprint on the Landscape: Our Role as Guardians

In this panoramic view of the landscape, it is interesting to highlight two key aspects. Firstly, geological resources provide valuable services to society, allowing for the conservation of natural heritage, but they can also lead to its loss if not managed sustainably. Secondly, we observe how humans have the ability to modify the landscape and create new morphologies, leaving a human imprint on our environment. Every Action Counts: Be a Guardian of Our Aquifers You too can make a difference in your everyday life. Think twice before disposing of hazardous waste in drains or on the ground. By doing so, you can prevent soil and groundwater contamination, safeguarding nearby surface waters. Ensure proper disposal of medications, oils, and chemicals! Even something as simple as not littering contributes to protecting our valuable aquifers.

NINTH STOP

Key Idea:

Explore the relationships between passerine birds and the Peñas Negras environment, highlighting interesting facts about these birds.

Learning Objective:

Demonstrate the connections between passerine birds and the natural environment of Peñas Negras.

Emotional Objective:

Evoke positive emotions such as astonishment, admiration, and curiosity.

Passerine Birds: The Flying Gardeners of Peñas Negras

Imagine having a large garden filled with beautiful flowers, but suddenly, small insect pests threaten to destroy its beauty. It would take a team of gardeners to protect and maintain that beautiful garden.

In Peñas Negras, something similar happens. The birds inhabiting this forest are like flying gardeners. They play a crucial role in the ecosystem by controlling insect pests that could cause environmental disasters. These birds, as expert natural "exterminators," feed on insects and keep them in check.

But that's not all; these birds also play a significant role in seed dispersal. While feeding on the fruits of trees and shrubs, the seeds pass through their digestive systems and are excreted in different locations. This contributes to the spread of plants and helps maintain the diversity and health of the forest.

They are ideal flying gardeners! They collaborate with the ecosystem by controlling pests and aiding in plant reproduction. Their presence in Peñas Negras is essential for maintaining the natural balance and preserving the biodiversity of this wonderful environment.

Among the birds inhabiting this ecosystem are the Eurasian blue tit (*Cyanistes caeruleus*), the great tit (*Parus major*), the crested tit (*Lophophanes cristatus*), and the coal tit (*Periparus ater*).

Meet these remarkable protagonists in the natural environment...

These birds are renowned for their extraordinary agility and acrobatic abilities. Watching them hang from branches and make rapid, precise movements while foraging for food is a breath-taking spectacle.

In addition to their grace in flight, these birds stand out for their intelligence and learning capabilities. Scientific studies have demonstrated their problem-solving skills, including learning to open lids to access food. Their rapid learning ability and variety of food acquisition strategies make them fascinating species to observe.

CONCLUSION/INTERMISSION

Key Ideas:

-Limestone in Peñas Negras is fundamental as the basis of the ecosystem, beautifying the mountain and serving as a reservoir for freshwater in springs and rivers that supply our daily lives.

-Summarize the challenges faced by the mountain as mentioned during the georoute.

-The need to care for and value Peñas Negras as a way of taking care of ourselves, recognizing that our connection to nature is essential for our long-term well-being.

Emotional Objective:

Generate admiration, empathy, and compassion for the Peñas Negras Massif and appreciate the beauty of both biotic and abiotic nature.

Behavioural Objective:

Commit to more sustainable consumption, avoid soil pollution, and respect the territory.

Peñas Negras: A Legacy of Generosity and Connection

In our georoute through Peñas Negras, we have witnessed the intricate interconnection of nature and the immense value that limestone brings as its sturdy foundation. This rock not only beautifies and constructs this mountain but also serves as a reservoir of freshwater, sustaining the springs and rivers that supply our daily lives when we turn on the tap in our homes. What valuable gifts the presence of limestone adorning and building Peñas Negras allows us to have!

Furthermore, we have witnessed the admirable resilience of nature in Peñas Negras. Facing challenges like climate change and adverse conditions, the holm oak forests of the region have demonstrated their tenacity by adapting and finding survival strategies. We learn from nature that it always finds a way to prevail, although it is also evident that it needs time to heal and recover.

Take, for example, the COVID-19 pandemic, which showed us how nature rejuvenates when given respite from human impact. However, we often focus on immediate benefits and fail to consider long-term consequences. Just as excessive junk food consumption affects our long-term health, the unchecked exploitation of natural resources, such as eucalyptus planting and ongoing limestone quarrying, has a negative impact on the natural environment and, consequently, on society.

Peñas Negras has endured these challenges with courage and resilience. Despite the afflictions we have imposed upon it, we have also attempted to mitigate the impacts, and now it is a protected reserve.

It offers us a marvellous landscape, clean air... it is a mountain designed to give, and in return, we must care for and value it. By connecting with the essence of Peñas Negras and enjoying its presence, we can honour its generosity and respond in kind.

Peñas Negras invites us to recognize that our connection to nature is not only based on its intrinsic beauty and magnificence but is also essential for our long-term well-being. By caring for and preserving this resilient mountain, we take care of ourselves.

As we bid farewell to the mountain, let us carry with us love and gratitude for Peñas Negras, committing to protect and enjoy its magnificence. We invite you to continue your exploration with two more sites that delve deeper into the topics covered on your journey through Peñas Negras! Discover why the soil of the Escobedo Valley is so special and how overexploitation of aquifers has affected our territory.

TENTH STOP

Key Idea:

The soil in the Escobedo Valley is special and is a non-renewable resource.

Learning Objective:

Recognize that the soil in the Escobedo Valley is especially fertile and understand that its loss due to housing construction is irreversible.

Discover the Special Fertility of the Escobedo Plain

From this privileged viewpoint, you can admire the unparalleled Escobedo Plain and discover one of its most precious natural gems: its exceptional soils that make this place extraordinarily fertile.

The soil of the plain is composed of decalcification clays, derived from the breakdown and erosion of limestone rock. They are especially fertile for several reasons:

• Water Retention: Clays have a high capacity to retain water and nutrients, providing a constant supply for plant growth. The healthier the soil, the better the harvest.

• Essential Nutrients: These clays contain essential minerals and nutrients for plants, such as calcium, potassium, and magnesium. These nutrients are released slowly as the clays decompose, providing a constant supply of nutrients for plants.

• Balanced pH: Decalcification clays have a nearly neutral or slightly acidic pH, which promotes root development and nutrient absorption by plants.

• Soil Structure: These clays improve soil structure by increasing its water and nutrient retention capacity, allowing for better root development and greater nutrient availability for plants.

Losing Soil, Losing Our Future: The Silent Threat Beneath Our Feet

Soil is a valuable but limited resource. It does not regenerate at a fast enough rate for continuous use. In fact, it is estimated that it takes approximately 1000 years for the Earth to generate just 1 cm of new soil. This means that if you were to dig a hole in the ground today, around 40 generations in your family tree could pass before that spot has 1 cm of new soil.

According to a 2019 UN report, 24 billion tons of fertile soil are lost worldwide every year, which is a pressing concern. In the Escobedo Plain, we have exceptional soils that are crucial for food production. Every area of soil lost to housing construction represents a loss of potential to grow food and ensure our long-term food security. The Escobedo Plain is a treasure of special fertility that must be protected to ensure a sustainable future.

Let's seize this opportunity to value and care for our soils, thereby guaranteeing the prosperity and well-being of future generations in the Escobedo Plain!

ELEVENTH STOP

Key Idea:

Overexploitation of aquifers leads to serious social and economic problems.

Learning Objective:

Understand that unbalanced aquifer exploitation is not a sustainable measure for the future.

Depleted Waters, Fragile Land: Lessons from a Mining Past

Pozón de la Ruperta is an artificial lake that bears witness to Camargo's mining past. In the past, the "Bairds Mining Company Ltd." extracted iron ore through open-pit mining. In their process of washing and extracting the ore, they used large quantities of water drawn from underground aquifers through wells and pumps. However, this practice had social and economic consequences.

When Water Depletes the Land: The Destructive Effects of Excessive Extraction

Excessive groundwater extraction weakened the terrain's structure and caused soil collapse. The resulting sinkholes, known as "soplaos," jeopardized the safety of citizens and their properties.

Changing Strategy

In response to this issue, the mining company decided to utilize a depression in the terrain, the doline, to create Pozón de la Ruperta. They sealed the doline's sinkhole and made it impermeable, turning it into an artificial lake.

Lessons Learned

The history of Pozón de la Ruperta teaches us the close relationship between groundwater extraction and the consequences for land stability. Overexploitation of aquifers can compromise the safety of communities and create long-term economic problems. Therefore, it is essential to understand that overexploitation of aquifers is neither an efficient nor sustainable solution.

3.2.2 Proposal 2 – Didactic guide

3.2.2.1 Introduction and objectives

Within the educational programme of the geopark, a fundamental need is to strengthen the connection with formal education. Although there is already a close relationship with various educational institutions that conduct field trips, the aim is to further facilitate and encourage collaboration with institutes, as well as promote the recognition of the geopark's value in the territory. It is of great importance for students to familiarize themselves with and appreciate their local environment and nature in general.

To address this need, a pilot project has been developed as an educational resource for educators. This resource will be used annually in the geography course at the IES Ría del Carmen Institute, located in Maliaño. The resource is designed for 1st-grade students of Mandatory Secondary Education (ages 12 to 13) and has been created in collaboration with the teaching staff, taking into account their needs and the curriculum.

The didactic guide focuses on a field trip proposal that includes pre-field and post-field activities, according with common best-practices suggested for instance by Orion, 1989 and Henrique et al., 2012. The field trip emphasizes external agents that have shaped the landscape over time, with a secondary focus on the distribution of freshwater on the planet, particularly highlighting the significance of groundwater in shaping Camargo municipality's karst landscape.

The overall objective of this activity is to enhance students' understanding of the dynamic nature of Earth and the factors that have influenced landscape formation throughout history. It emphasizes the crucial role of water as a fundamental agent in landscape modelling, with a specific focus on the karst landscape and its connection to water's role as a terrain shaper.

Detailed objectives of the activity and a comprehensive description of its three phases (pre-field, field trip, and post-field) are provided in Annex 7. This educational resource will serve as a valuable tool for teachers and provide an enriching experience for students, fostering a stronger connection with the local environment and cultivating a deeper appreciation for nature within the geopark.

3.2.2.2 Target group

The target group consists of children between the ages of 12 and 13 who are students at the IES Ría del Carmen Institute in Spain. These children are typically in the first year of Secondary Education, commonly referred to as 1º de la Educación Secundaria Obligatoria (ESO).

According to various sources (Stewart, 2013b; CDC, 2021; Gordon, 2022; McLeod, 2023) that delineate the fundamental attributes of this specific group, the following characteristics have been identified:

1. **Age**: The students are in the early adolescent stage, with ages ranging from 12 to 13 years old. This age group is generally characterized by significant physical and emotional changes as they transition from childhood to adolescence.

2. **Cognitive Development:** At this age, children are developing more complex cognitive abilities, including enhanced critical thinking, problem-solving skills, and a deeper capacity for abstract reasoning.

3. **Social Development:** Social relationships become increasingly important at this stage, as students seek to establish their identities within peer groups and become more aware of social norms and expectations.

4. **Interest in the Environment**: Children in this age range often show a growing interest in the natural world and may be eager to learn about geological formations, landscapes, and environmental processes.

5. **Relevance of Experiences:** Learning experiences that are relevant to their immediate environment and experiences are likely to be more engaging and impactful for this age group.

6. **Varied Learning Styles:** Students in this age group may have different learning styles, and educators may need to incorporate diverse teaching methods to accommodate their individual preferences.

7. **Hands-On Learning:** Active and hands-on learning experiences are beneficial for this age group, as they encourage exploration, problem-solving, and a deeper understanding of the subject matter.

8. **Receptive to Technology:** Many students in this age range are comfortable with and receptive to technology, making digital resources and interactive learning tools effective in engaging them.

3.2.2.3 Implementation Plan

The implementation of the didactic guide is scheduled to commence in October, coinciding with the start of a new school year. The plan aims to ensure a successful and effective integration of the guide into the educational program at the IES Ría del Carmen Institute and to continuously recalibrate and improve the guide based on feedback and observations from teachers and students. The Implementation Plan can be outlined as follows:

Training of Educators: Before the start of the new school year, a training session will be conducted for educators who will be using the didactic guide in their geography classes. This training will provide them a comprehensive understanding of the guide's objectives, content, and implementation strategies.

Customization: During the preparatory phase, teachers will be encouraged to customize certain aspects of the guide to align it with the specific needs and preferences of their students. This customization will help to make the learning experiences more relevant and engaging for the target group.

Pilot Run: The first implementation of the didactic guide will be treated as a pilot run. This approach allows for testing the guide's effectiveness in real classroom settings, identifying potential challenges, and gathering valuable feedback from both teachers and students.

Data Collection: Throughout the initial implementation, data will be collected through surveys, observations, and feedback sessions with teachers and students. This data will serve as the basis for evaluating the guide's impact and identifying areas for improvement.

Continuous Assessment: Following the initial implementation, a thorough assessment of the didactic guide's strengths and weaknesses will be conducted. This evaluation will help in identifying any modifications or adjustments needed to enhance its effectiveness.

Regular Feedback Sessions: Feedback sessions with educators will be scheduled periodically to discuss their experiences, suggestions, and challenges encountered during the implementation process. This iterative feedback loop will be essential for refining the guide and addressing any issues promptly.

Student Evaluation: The students' perspectives will also be sought through surveys or discussions to gauge their engagement levels, comprehension of the material, and overall satisfaction with the learning experiences provided by the guide.

Dissemination: If the implementation proves to be effective, there may be opportunities to share the didactic guide with other educational institutions or geoparks, thereby contributing to broader educational initiatives and promoting the value of geoparks in the region.

By following this implementation plan, the didactic guide for the Institute IES Ría del Carmen will be well-integrated into the curriculum, effectively fostering a deeper understanding and appreciation of the local environment and geological features among the 12 to 13 years-old students. The ongoing recalibration process ensures that the guide remains relevant and impactful, providing a valuable resource for educators and students in subsequent school years.

Chapter 4: Conclusions and recommendations

4.1 Conclusions

This internship report has delved into the exploration and analysis of various educational initiatives and proposals developed for CQAG. The main objective of this report was to contribute to the enhancement and enrichment of the geopark's educational programme, with a focus on promoting scientific and technical knowledge among the general population, especially the younger generation.

Throughout the internship period, we successfully participated in and contributed to two significant programmes within the educational department of the geopark: the Ecological Garden and "PequeIngeniería" Workshops. Both activities provided valuable insights and lessons for future implementations and enriched the overall professional experience. Notably, the "PequeIngeniería" Workshop emerged as a successful venture, effectively imparting an understanding of geological time. The design of the georoute presented challenges in connecting visitors and tourists with the information through comparisons and illustrations, aiming to foster a sense of identification. The development process of the georoute demanded empathy and a sense of care, not just for nature, but also for the visitors, with the intention to unveil hidden truths that would cultivate a greater appreciation for their environment and promote a sense of interconnectedness. Moving forward, efforts will be directed towards continuous content recalibration and target group testing. The didactic guide, aimed at formal education, targeted students at the IES Ría del Carmen Institute and presented them with engaging opportunities to explore the dynamic nature of Earth and the role of water in shaping landscapes.

During the implementation and design of these programs, there was the possibility to interact with diverse target groups, including children, educators, and local experts. Their active participation and positive feedback demonstrated the value of the educational initiatives. Furthermore, the collaboration with local experts, educators, and the geopark team greatly enriched the development and execution of these initiatives.

The educational proposals, including the georoute and didactic guide, were designed to align with the specific needs and characteristics of the target audiences. By utilizing interactive and immersive learning experiences, its aimed to foster curiosity, critical thinking, and an appreciation for the natural environment. The inclusion of pre-field and post-field activities for the didactic guide ensured a holistic learning process that extended beyond the classroom.

My participation in the internship not only contributed to the educational programme of the geopark project, but also had a significant impact on my personal development and growth as an individual. The experience of creating educational material aimed at diverse audiences enhanced my pedagogical and communication skills. This latter skill was also strengthened through my involvement in scientific outreach, creating content for the georoute, where translating complex scientific concepts into accessible language for the general public was necessary. The knowledge acquired during my master's degree and consultation of Freeman Tilden's book "Interpreting Our Heritage" proved to be extremely valuable tools for putting this skill into practice.

As mentioned earlier, the ability to interpret our environment resembles an exercise in empathy, requiring one to place themselves in the visitor's shoes to provide the best possible experience. During my experience in interpretation, this quality seemed to me one of the most relevant, if not the most important. Additionally, the process of designing activities based on the needs of the educational program and diverse audiences increased my adaptability and flexibility in approach.

Another valuable experience gained was hands-on project management, as it was essential for planning and executing the two implemented educational activities, as well as creating content for the georoute and the teaching guide. Through the mistakes made and lessons learned during the planning of these projects, I have acquired valuable insights that I will undoubtedly apply to future challenges involving project management.

Finally, my involvement in the educational programme of CQAG and my participation in crafting educational resources designed to encourage understanding and admiration for the region's natural and cultural heritage, all while nurturing a sense of belonging, is the source of my most profound personal fulfilment. Experiencing a sense of accomplishment and recognizing that these activities have both presently and potentially in the future made positive contributions not only to the natural environment but also to individuals themselves is truly rewarding.

4.2 Recommendations

Based on the experiences and observations, the following recommendations are presented to further strengthen the educational department of CQAG:

- ✓ **Continuation and Expansion:** The "PequeIngeniería" Workshop proved to be a successful outreach initiative. It is recommended to continue representing the geological timescale as a longer line and adapting it to role play to make it a more efficient learning and thus continuing and expanding this program to reach more schools and communities within the geopark's territory. This will help inculcate an early interest in science and engineering-related subjects among young learners.

- ✓ **Collaboration with Educational Institutions:** Strengthen the collaboration with local educational institutions, such as schools and colleges, to integrate geopark-related content into their curriculum. By aligning with formal education, the geopark can establish itself as an invaluable educational resource.

- ✓ **Professional Development for Educators**: Organize regular workshops and training sessions for educators to familiarize them with the georoute, didactic guide, and other educational resources. This will enhance their capacity to deliver impactful learning experiences and connect students with the geopark's geological heritage.

- ✓ **Digital Learning Resources:** In an increasingly digital world, it is going to be consider developing digital learning resources, such as interactive maps, virtual tours, and educational games, to complement the traditional educational materials. These resources can further engage students and visitors, especially those receptive to technology.

- ✓ **Visitor Evaluation and Feedback:** Implement a structured visitor evaluation and feedback system to continuously assess the effectiveness of educational initiatives. This feedback will provide valuable insights for improvement and refinement of the programmes.

- ✓ **Long-Term Impact Assessment:** Conduct long-term impact assessments of educational initiatives to measure their influence on students' knowledge, attitudes, and behaviours related to geology, environmental conservation, and sustainable practices.

- ✓ **Collaboration with Geoparks Network:** Foster collaboration with other geoparks within the network, sharing best practices, educational resources, and experiences. This collaboration can strengthen the overall impact of geoparks on education and conservation.

- ✓ **Community Engagement:** Engage local communities in the development and promotion of educational programs. Involving the community will foster a sense of ownership and identity in the geopark's initiatives and encourage active participation.

By continuing implementing these recommendations, the Costa Quebrada Aspiring Geopark can further enhance its educational programme, creating a lasting impact on its visitors, students, and communities. The continuous improvement and adaptation of educational initiatives will contribute to the geopark's mission of promoting scientific knowledge, environmental awareness, and sustainable practices within the region and beyond.

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ANNEX 1. Landscape analysis municipality of Camargo

LANDSCAPE ANALYSIS MUNICIPALITY OF CAMARGO

Geographical location and population

Camargo is one of the eight municipalities encompassed within the defined geographic boundaries of Costa Quebrada Aspiring Geopark (Figure 1A). To the north, it borders with Santander, while the northwest is adjacent to Santa Cruz de Bezana. To the east, it is surrounded by the Bay of Santander and the area of El Astillero, and to the southwest and south, it shares boundaries with Piélagos. Its close proximity to the city of Santander, the capital of the autonomous community of Cantabria, has contributed to its economic and social dynamism (Gómez et al., 2000). The connection of Camargo with the nearby settlement of Torrelavega, located approximately 20 km away, further enhances its dynamism. Torrelavega serves as the second largest population centre in Cantabria and maintains constant interaction with the capital, thereby impacting the municipality of Camargo (Gómez et al., 2000).

Within the municipality, there are eight communities: Cacicedo, Camargo, Escobedo, Herrera, Igollo, Maliaño, Muriedas, and Revilla (Figure 1B). Muriedas serves as the municipal capital. The municipality has a population of 30,374 inhabitants (OACNIG, 2023), making it the third most populous municipality in Cantabria. Muriedas and Maliaño have the largest number of inhabitants.

Geodiversity

The municipality of Camargo comprises an area of 36.98 km^2 (OACNIG, 2023) and features gently sloping terrain with relatively low altitudes (Figure 2 and 3). The highest point in the municipality is Pico de Obeña, reaching 278 meters (Gómez et al., 200; López, 2014). Precisely, the toponym "Camargo" historically refers to the "low land by the sea," accurately reflecting the physical characteristics of the area (Gómez, 2000). Moreover, its relief is characterized by a prominent karst landscape, exhibiting extensive decalcification basins with small residual hills, which are surrounded by limestone formations (Figure 4). The prevalence of limestone rock throughout the area has played a crucial role in shaping the distinct karstic features, including sinkholes, karren, and other characteristic relief forms.

The following description of the geological history that shaped the current relief is summarized using information primarily sourced from the book "Catálogo de cavidades del municipio de Camargo" (Muñoz et al., 2002). The varied morphology observed in the municipality of Camargo today has been influenced by the distribution of diverse lithologies and geological structures.

The area contains extensive and thick Mesozoic materials, covered by Quaternary materials (Figure 5). The oldest materials belong to the Triassic Period and are found near the Bay of Santander, in flat or semi-flat areas like Las Presas and the northwest of Maliaño. These rocks consist of plastic clays of different shades, interspersed with gypsum and occasional presence of salt.

The lithological formations of the Jurassic Period that follow chronologically are mainly composed of dark clayey limestones and marls rich in organic matter and pyrite. Furthermore, these formations are rich in fossils, including belemnites, brachiopods, ammonites, bivalves, and ostracods. Continuing in the succession, Cretaceous rocks occupy the largest extent and thickness in the municipality, especially for Lower Cretaceous (144 to 99 million years ago) and are of sedimentary nature. These materials form a synclinal structure around the Escobedo area, with the more recent rocks at its core, located between the towns of Igollo and Azoños. The remaining lithologies in Camargo are from the Quaternary Period, generally poorly cohesive and poorly lithified, and in some areas, covering extensive areas and with appreciable thicknesses over the previous lithologies. These materials are also prominent, mainly due to the prevailing climate in Cantabria, characterized by abundant rainfall and mild temperatures. These conditions favour the alteration of the existing lithologies, leading to the formation of natural soils and other accumulations such as decalcification clays and marshes. The Quaternary materials mainly occupy the flat areas of the municipality.

In addition, Mesozoic rocks have undergone tectonic stresses, including folding and fractures associated with the main Pyrenean movements (Neo-Alpine tectonic phases) that occurred during the Eocene. There are also indications of earlier movements in the Cretaceous, during the Aptian, Albian, and Cenomanian Stages. As a result of all these tectonic efforts, gentle folds with east-west or northwest-southeast orientations were formed, as well as intense fracturing. The phenomenon of diapirism has greatly contributed to the intense fracturing in the area, which is related to tectonic activity and partly caused by tectonic stresses. These occurrences are made possible by the presence of plastic and relatively light materials at deep that underwent tectonic stress and lithostatic deformation, which sometimes affected large portions of the lithologies above them.

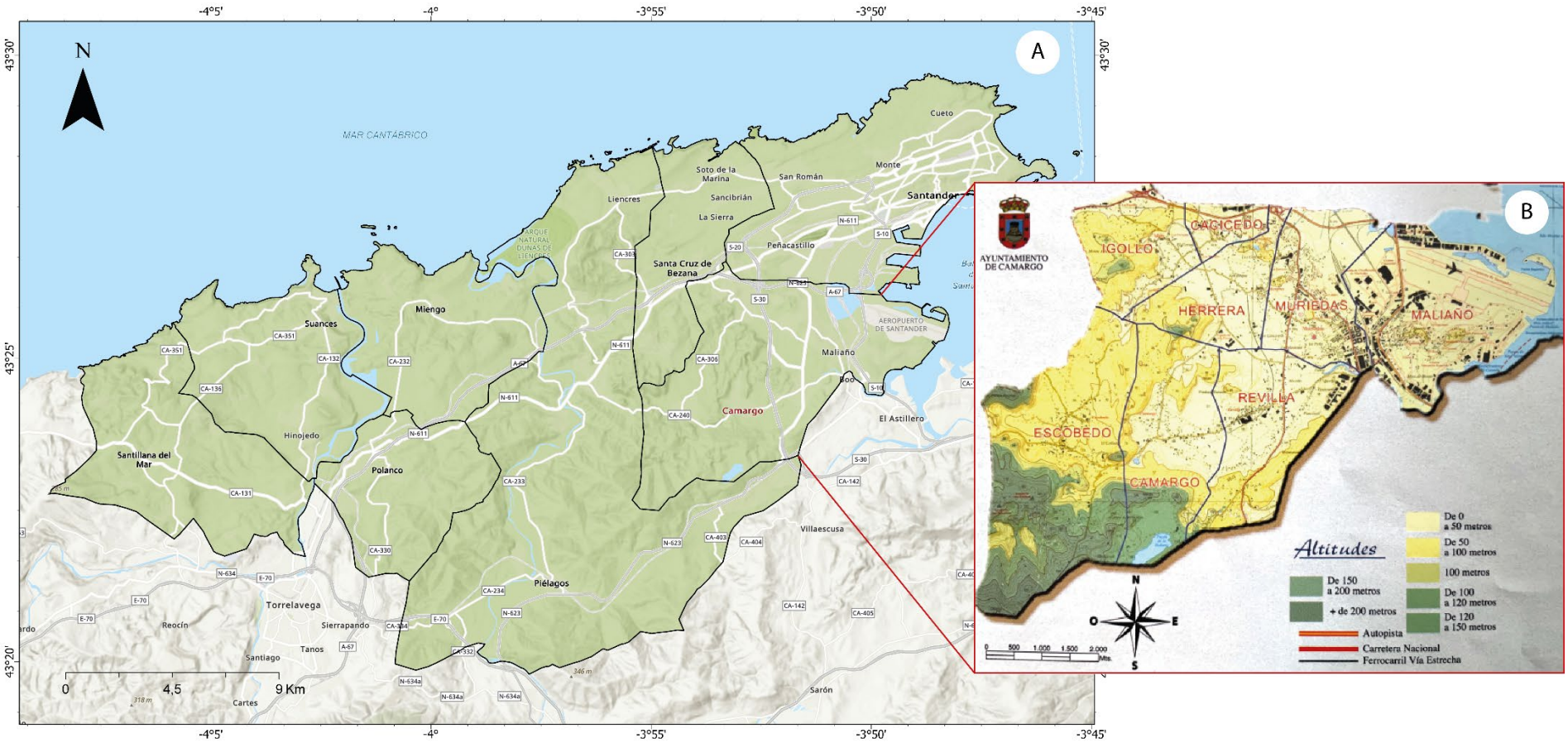

Figure 1. A) Administrative map of the Costa Quebrada Aspiring Geopark at the municipality level. B) Administrative map of the municipality of Camargo (taken from Muñoz et al., 2002).

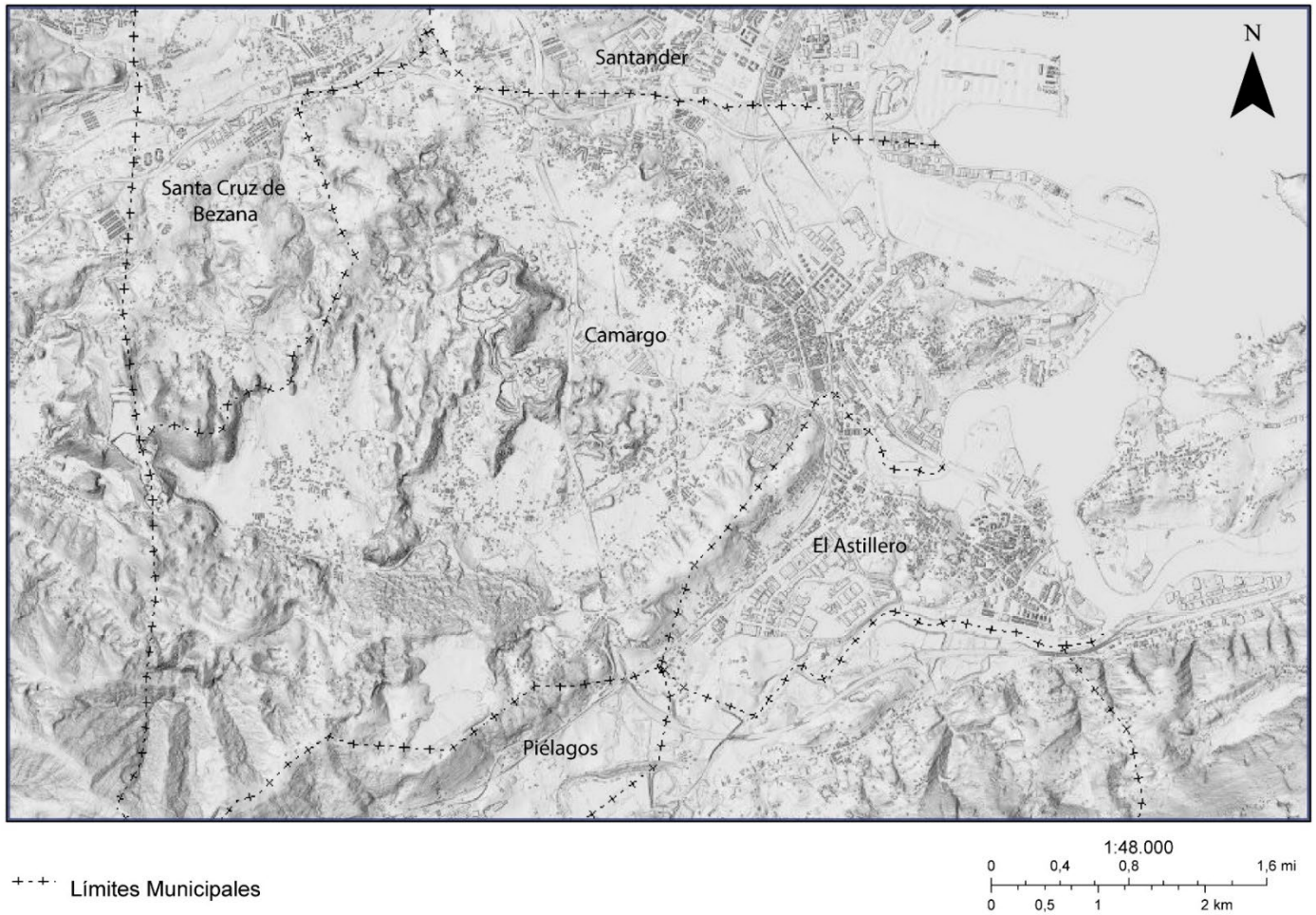

Figure 2. Map showing the topography of Camargo municipality and its surrounding areas (generated using the Cantabria government's geographic information viewer).

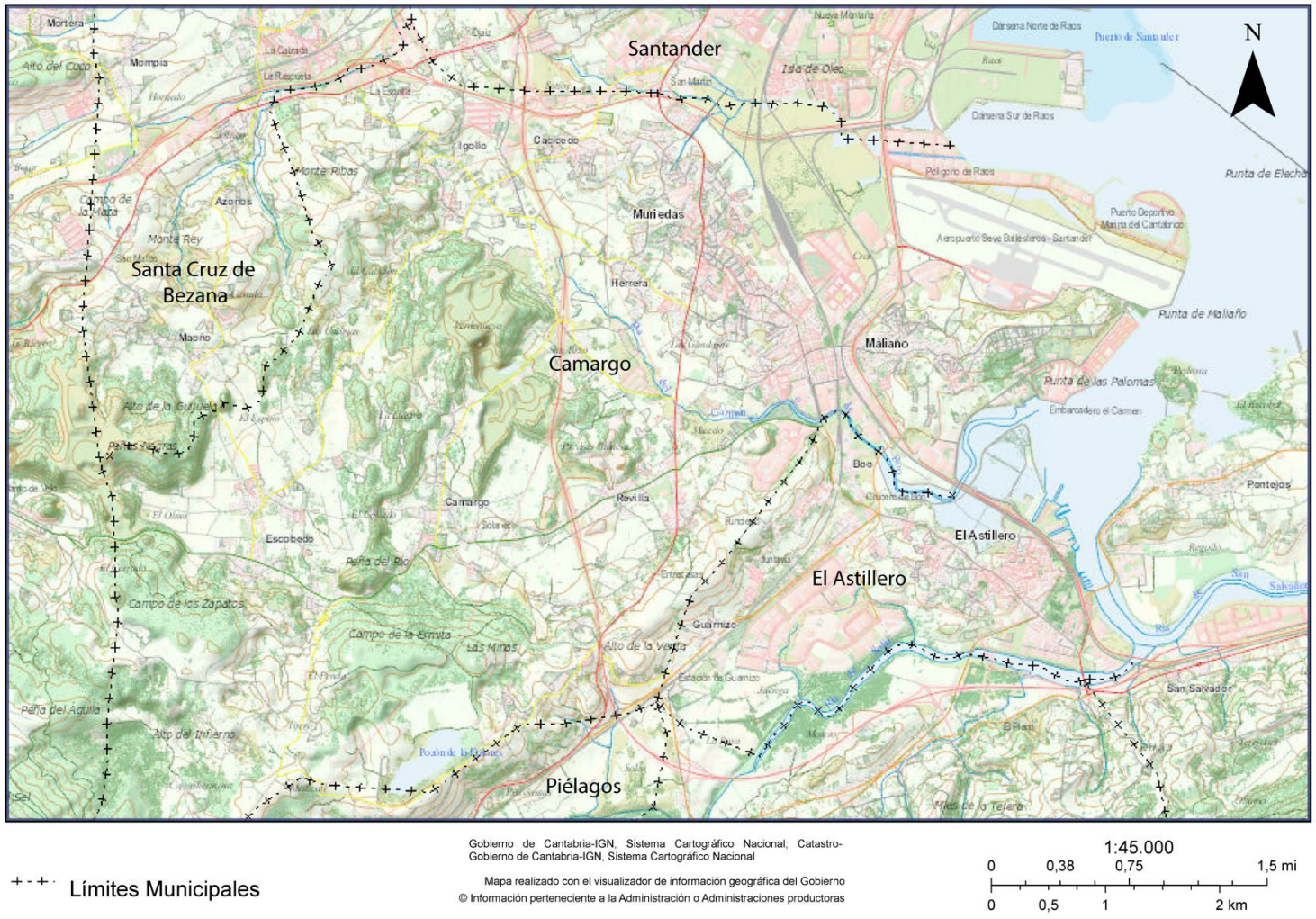

Figure 3. Geographical map of Camargo municipality (generated using the Cantabria government's geographic information viewer).

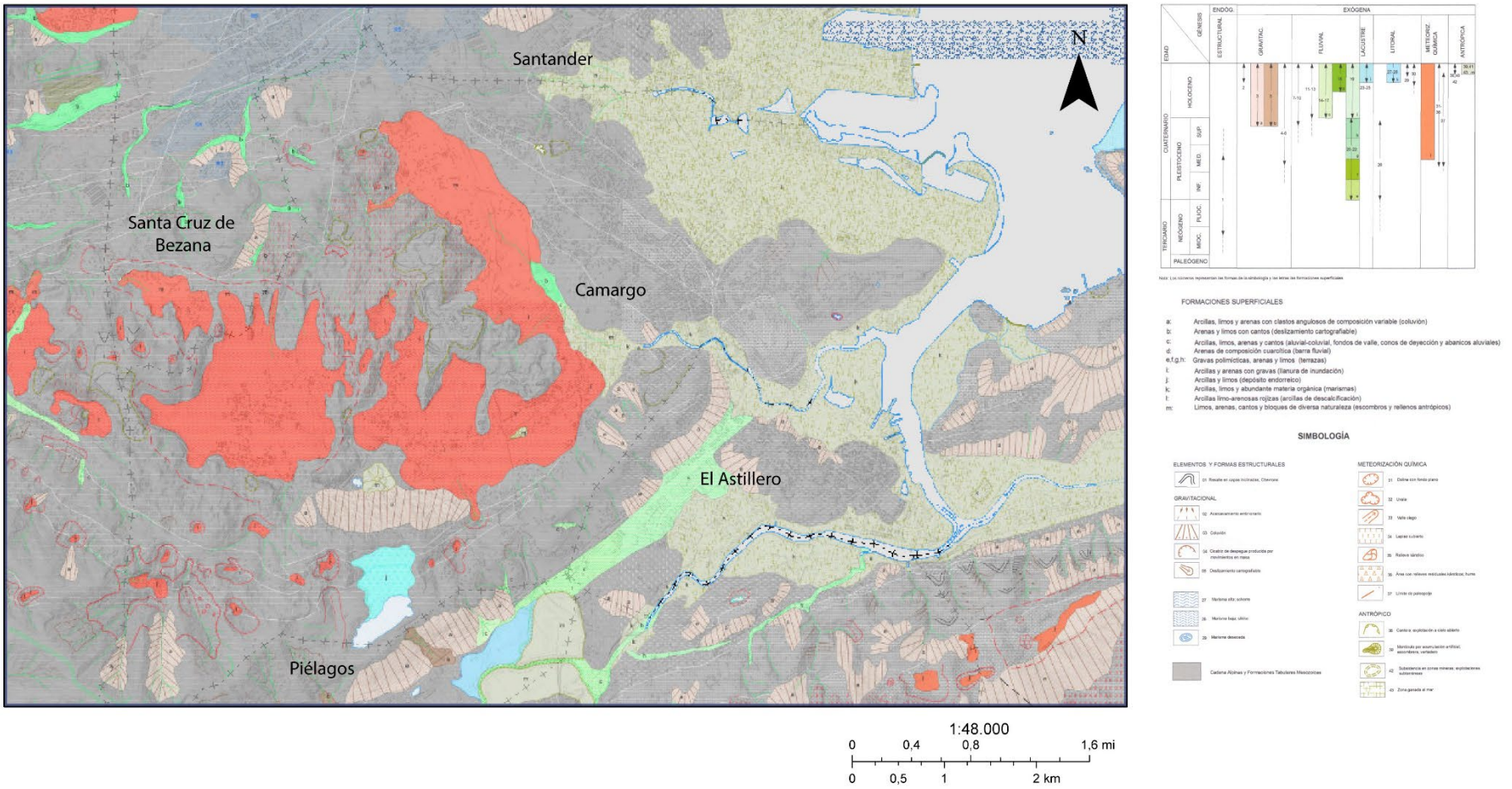

Figure 4. Geomorphological map of the municipality of Camargo and surrounding areas (IGME, 2017a)

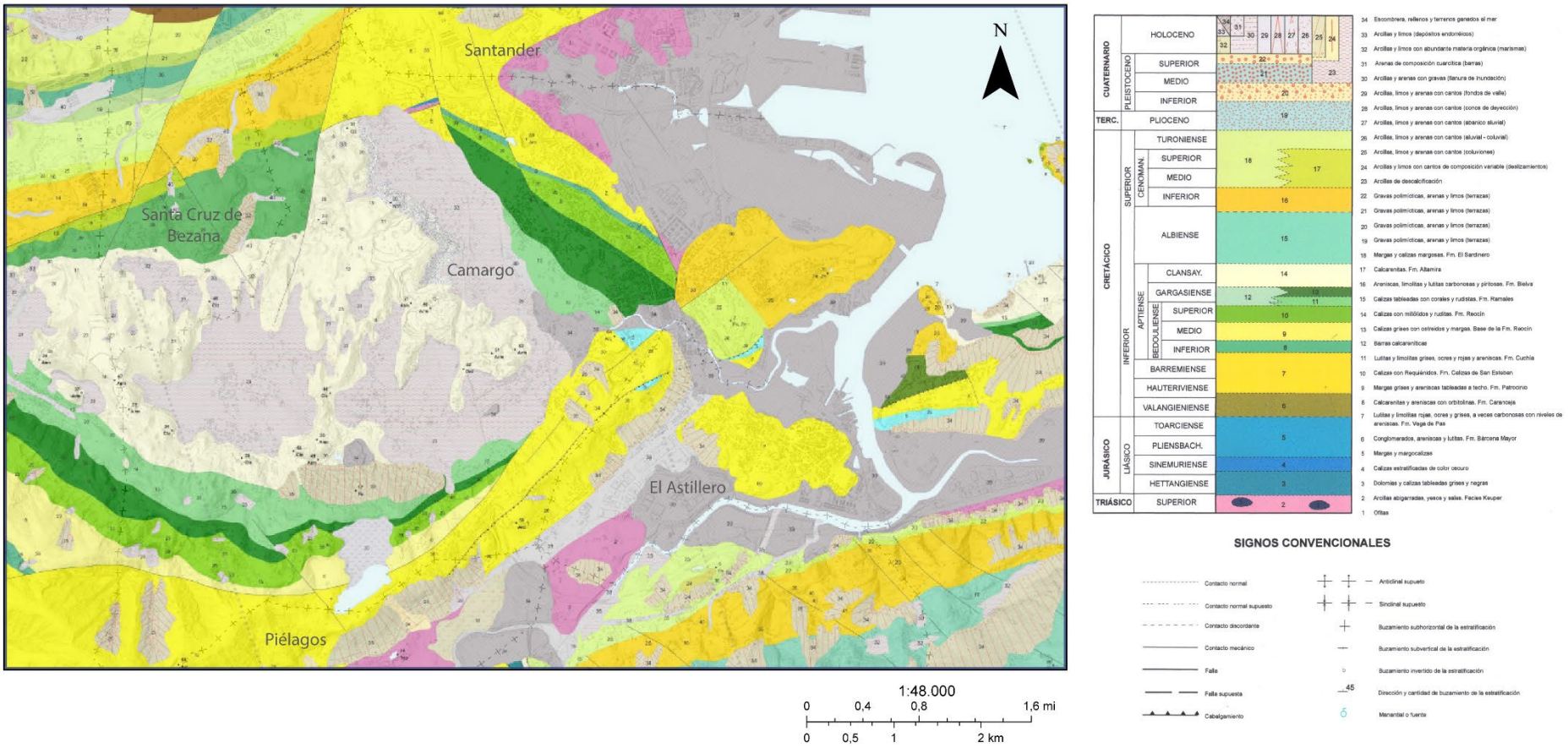

Figure 5. Gelogic map of the municipality of Camargo and surrounding areas (IGME, 2017a)

Biodiversity

Over the years in Camargo, as well as around the world, natural areas with native vegetation have been increasingly reduced due to ongoing human activities. In the past, the dominant natural ecosystems that shaped Camargo's landscape were predominantly the Atlantic deciduous forest (Muñoz et al., 2002; López, 2014), accompanied by marshlands, holm oak, and mixed forests. However, as modern society evolved, these ecosystems faced degradation, prompting efforts to promote their natural recovery. This led to the establishment of the Network of Protected Municipal Spaces, a measure aimed at safeguarding and restoring the ecological balance (Sánchez & Valdeolivas, 1995). Currently, several natural environments within the municipality are recognized as valuable heritage resources. These include the Municipal Reserve of the Alday and Parayas, as well as the Raos Marshes in Muriedas. Additionally, the Municipal Reserve of the Pozón de la Dolores Wetland in Revilla, the holm oak forest of the Sierra de Peñas Negras in Escobedo, and the Punta Parayas Park in Maliaño are also regarded as important conservation areas (Lobato, 2012).

Marshlands characterized by their swampy nature and infiltration of seawater or tidal waters (Oxford Languages, 2022), support a diverse range of biological life. These areas play a crucial role in providing habitats for crustaceans, invertebrates, molluscs, and various vertebrates (Sánchez & Valdeolivas, 1995). Camargo is fortunate to still possess some surviving marshlands, such as those found in Alday and Parayas, which also feature the Raos Estuary on their outskirts. Additionally, the main estuary in the municipality is the Boo Estuary, where small streams like Bolado, La Mina, and Collado converge (Muñoz et al., 2002). The marshlands are renowned for maintaining the biological quality of Camargo's vertebrate fauna, with birds being the main representatives of this diversity, seeking refuge and nesting in these areas (Sánchez & Valdeolivas, 1995; López, 2014).

Another ecologically significant ecosystem in the municipality is the evergreen oak groves, dominated by holm oak tree (*Quercus ilex*) and by laurel (*Laurus nobilis*) (Pérez et al., 1990; Sánchez & Valdeolivas, 1995). Understory species in these groves include plants such as strawberry trees (*Arbutus unedo*), butcher's broom (*Ruscus acuelatus*), alaternus (*Rhamnus alaternus*), olive trees (*Phyllirea latifolia*), madder (*Rubia peregrina*), and rough bindweed (*Smilax aspera*) (Pérez et al., 1990; Sánchez & Valdeolivas, 1995). These trees have adapted to the Mediterranean climate with its droughts and high temperatures, and their presence in Cantabria has been facilitated by the limestone rock formations that characterize the region. The karstic

nature of the terrain, with its filtering properties, prevents surface water accumulation, creating conditions similar to the arid Mediterranean climate (Pérez et al., 1990; Sánchez & Valdeolivas, 1995). While some remnants of these groves can be found around the minucipality, the larger areas are primarily concentrated in Peñas Negras (Escobedo) and the mountains of La Verde (between Revilla and Igollo) (López, 2004).

The mixed Atlantic forest, on the other hand, is dominated by oak trees (*Quercus robur*) and often intermixed with chestnut trees (*Castanea sativa*) (Sánchez & Valdeolivas, 1995). These forests surround the evergreen oak groves in the Camargo Valley and can be observed in the Sierra Pendo-Cavidón and Igollo areas (Sánchez & Valdeolivas, 1995; López, 2014). This type of ecosystem typically thrives in regions with low nutrient content or organic matter, where limestone lithology is absent. The understory of the mixed Atlantic forest includes species such as holly (*Ilex aquifolium*), hazel (*Corylus avellana*), lungwort (*Pulmonaria longifolia*), and wood sorrel (*Oxalis acetosella*) (Sánchez & Valdeolivas, 1995).

Among the activities that have contributed to the reduction of these ecosystems is the cultivation of eucalyptus forests, which are managed as agricultural crops and lack the ability to support biodiversity (Veiras & Soto, 2011). In Camargo, eucalyptus species (*Eucalyptus globulus*) are accompanied by vegetation such as gorse (*Ulex europaeus*) and brambles (*Rubus ulmifolius*) (Sánchez & Valdeolivas, 1995). The impact of these plantations varies depending on factors such as the species used, soil conditions, plantation management, scale in relation to other tree formations, landscape biodiversity, and daily practices (Veiras & Soto, 2011). In Camargo, eucalyptus plantations have led to soil impoverishment and the displacement of native ecosystems (Gómez et al., 2000). While eucalyptus stands are widespread in the municipality, notable plantations can be found in the Camargo Mine and in Escobedo. It is important to note that eucalyptus plantations that preserve fragments of native forests may not necessarily conform to the general rule of low species richness and reduced trophic resources (Sánchez & Valdeolivas, 1995).

Additionally, the pastures in Camargo are semi-natural spaces where human intervention has disrupted the ecological dynamics, preventing the natural progression of these lands into forests (Sánchez & Valdeolivas, 1995). Dominated by grasses and legume species, these pastures provide habitat for various vertebrate species, including red kites (*Milvus milvus*), common buzzards (*Buteo*

buteo), Pyrenean voles (*Pitymys pyrenaicus*), and beech martens (*Martes foina*). Pastures are found in the population entities of Camargo, Revilla, Igollo, and Escobedo.

Economy

The municipality of Camargo has undergone three distinct economic stages throughout its history. Initially, an agrarian economy prevailed with a focus on cereal and vine cultivation (López, 2014). During the 20th century, there was substantial growth in livestock farming, particularly in the dairy sector and cattle breeding. This period was followed by a significant shift towards industrialization, which became the driving force of the local economy until the mid-1980s (López, 2014).

Prior to the 20th century, agriculture was the primary economic activity in Camargo, with crops like wheat, barley, millet, and spelt playing a crucial role (Gómez et al., 2000). In the latter half of the 20th century, the primary sector shifted its focus to dairy production, although fishing also experienced growth in specific areas. Concurrently, the secondary sector played a pivotal role in Camargo's economic development, with the municipality gaining recognition as an industrial hub (Gómez et al., 2000; López, 2014).

Throughout its history, Camargo has witnessed the extraction of various mineral resources, including iron, limestone, dolomite, clay, and pyrite (Gómez et al., 2000). These mining activities, particularly quarrying, have significantly altered the municipality's landscape. Moreover, the filling of marshlands and urban planning have made substantial contributions to the process of industrialization (Gómez et al., 2000). As of 2014, the tertiary sector employed the largest share of Camargo's active population, accounting for 61.4%, making it the most dynamic sector in the municipality (López, 2014).

Cultural heritage

The cultural heritage of the Camargo Valley is one of the most extensive and valuable in the autonomous community of Cantabria. It includes 140 classified archaeological sites and numerous buildings of great historical and artistic value. Six elements have been declared Cultural Heritage of Interest, and another 31 have been proposed for declaration as Local Heritage of Interest. Among the archaeological sites, notable ones range from the Lower Palaeolithic to the Middle Ages, with La Verde, El Pendo, El Ruso, El Mazo, and El Juyo being the most relevant. From the Roman period, the discovery of first-century public baths located in the Maliaño cemetery stands out (López,

2014). From the Medieval period, the necropolis of San Pedro in Escobedo and the ruins of El Collado Castle are prominent.

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ANNEX 2. Ecological Garden Workshop

HUERTO ECOLÓGICO:

PROPUESTA DE ACTIVIDADES EDUCATIVAS

Objetivo de aprendizaje general:

- ✓ Al finalizar la actividad, los estudiantes podrán identificar al menos una característica del suelo y formular preguntas sobre su composición o función.

El anterior objetivo se evaluará con la actividad 3.

Público objetivo: 2° de primaria (32 estudiantes de 7 a 8 años)

Temática: *Explorando qué hay bajo nuestros pies: Descubriendo el mundo del suelo.*

Contenidos:

1. ***Interactuando con la roca madre:*** Los niños podrán explorar un tipo de material parental (roca madre) del suelo que existe en el municipio de Camargo y comprender que el suelo se forma a partir de la descomposición y fragmentación de las rocas a lo largo del tiempo. Aprenderán que existe una relación entre las rocas y el suelo a través de la observación de muestras y la actividad planteada.
2. ***Descubriendo el tiempo que toma formar un suelo:*** Los niños aprenderán que el suelo es el resultado de un proceso gradual que lleva mucho tiempo. Comprenderán que la formación del suelo puede tardar siglos o incluso miles de años, desarrollando así una noción de la importancia de proteger y cuidar este recurso natural.
3. ***Explorando organismos y componentes del suelo:*** Los niños podrán examinar la capa más superficial del suelo y descubrir los diversos organismos y componentes que lo habitan. A través de actividades de observación, como el uso de lupa, podrán identificar insectos, lombrices, microorganismos y materia orgánica presentes en el suelo, y así notar que el suelo está "vivo".
4. ***Destacando la importancia del suelo en nuestra vida diaria:*** Los niños aprenderán cómo el suelo es fundamental para nuestra vida cotidiana. A través de ejemplos y discusiones, comprenderán que el suelo es necesario para cultivar alimentos, sostener árboles y plantas, filtrar y purificar el agua, así como brindar hábitats a los animales. Se destacarán las formas en que podemos cuidar y preservar el suelo en nuestro entorno.

Comentario: La actividad 1 se realizará con los 32 estudiantes simultáneamente y luego se dividirán en 4 grupos de 8 niños para rotar en diferentes estaciones, entre las cuales están incluidas las actividades 2 y 3.

ACTIVIDAD 1:

Breve descripción:

"El viaje en la cinta del tiempo geológico"

Los niños se familiarizarán con la escala de tiempo geológico al desplegar una cinta métrica que representa la historia de la Tierra. A través de preguntas, diferentes voluntarios se ubicarán en distintos momentos geológicos, resaltando la inmensidad del tiempo y nuestra posición como una especie joven en la historia de la Tierra. Además, se destacará la edad aproximada de una muestra de roca caliza que se utilizará en una actividad posterior, permitiendo a los niños ubicarla en la cinta métrica y comprender cuándo se formó.

Tiempo: 15-20 minutos

Recursos: Cinta métrica, tarjetas de eventos importantes en la historia de la Tierra, muestra de roca caliza.

Metodología y pasos:

1. ***Preparación del espacio***: Desplegar y colocar la cinta métrica en el suelo, asegurándose de que esté bien estirada y se pueda leer claramente. Se bloqueará la cinta en la longitud necesaria, por ejemplo, 10 metros representen la edad de la Tierra. Esta línea representará la "cinta del tiempo geológico".

2. ***Explicación inicial:*** Introducir a los niños en la idea de que la Tierra tiene una historia extremadamente larga y que con esta actividad vamos a ver en qué momento de la historia de la Tierra aparecimos nosotros (entre otros eventos importantes en su evolución). Sólo se incluirán eventos más relevantes con lo que los niños puedan relacionarse o puedan haber oído antes.

3. ***Voluntario en el tiempo:*** Comenzando desde el evento más antiguo, seleccionar un voluntario y pedirle que se ubique en el lugar de la cinta métrica donde crea que ocurrió ese evento. Entregar en sus manos la tarjeta del evento geológico y permitir que el

voluntario tome su decisión y luego corregir su ubicación si es necesario, brindando la información correcta sobre el evento geológico correspondiente.

Continuar el proceso con el resto de los eventos geológicos importantes en la evolución del planeta Tierra. Seleccionar diferentes voluntarios para cada evento y repetir el procedimiento, permitiéndoles ubicarse en la cinta métrica y corrigiendo su posición si es necesario. Cada voluntario mantendrá su posición hasta finalizar de ubicar todos los eventos. Después de ubicar la aparición del ser humano en la Tierra preguntar por la formación del ejemplar de la roca caliza que se pasará y permitirles adivinar su edad.

4. ***Reflexión grupal:*** Después de ubicar varios eventos a lo largo de la "cinta del tiempo geológico", reunir a todos los niños y hacer una reflexión grupal sobre la vastedad del tiempo geológico en comparación con nuestra existencia como especie. Destacar la idea de que somos muy jóvenes en la historia de la Tierra y hacer la comparación con la edad de la roca caliza que se utilizará en una actividad posterior.

ACTIVIDAD 2:

Actividad diagnóstica:

En la actividad, se les pide a los niños que anoten en un papel las respuestas a dos preguntas sobre su conocimiento del suelo. Además, se establece un límite de tiempo de 5 minutos para que completen esta tarea. Esto permitirá evaluar el punto de partida de los niños y obtener una idea de su nivel de conocimiento previo sobre el suelo antes de iniciar la actividad principal.

1. ¿Qué es el suelo? ¿Dónde podemos encontrarlo?
2. Opciones: ¿Para qué crees que sirve el suelo? / ¿Crees que es importante? / ¿Por qué es importante?

   Estas dos preguntas pueden proporcionar una visión inicial sobre el nivel de conocimiento y comprensión que los niños tienen sobre el suelo.
3. Opciones: ¿Qué es lo que más te gusta del suelo y por qué? / ¿Cómo te sientes cuando caminas descalzo sobre la tierra o juegas en un jardín con tierra? / ¿Qué te hace sentir el suelo cuando lo pisas o tocas con tus manos?

Esta pregunta busca que el niño identifique y exprese aspectos específicos del suelo que le generen interés, curiosidad o agrado. Puede ser la textura, los colores, la posibilidad de encontrar insectos o plantas, o cualquier otro aspecto que el niño perciba como atractivo. La respuesta a esta pregunta proporcionará información adicional sobre la percepción emocional y la conexión que el niño tiene con el suelo. Recordar fomentar un ambiente de confianza y apertura para que el niño se sienta cómodo al compartir sus pensamientos y emociones.

Breve descripción:

"Explorando con Curiosidad: Conociendo a nuestro amigo Suelo"

Para esta actividad se seguirá la metodología de QFT (Question Formulation Technique: https://rightquestion.org/what-is-the-qft/) enfocada en el suelo, pero ajustada para realizar en un tiempo reducido y con niños de primaria. Los estudiantes se familiarizarán con el suelo al interactuar con una muestra de roca caliza y de suelo. Harán preguntas sobre el suelo siguiendo cuatro reglas, seleccionarán las 2 preguntas más importantes para ellos y al final de la jornada se responderán esas preguntas para conocer mejor a su amigo suelo.

Esta actividad busca fomentar la curiosidad y la participación activa de los niños, alentándolos a hacer preguntas y a indagar sobre el suelo. Promueve el pensamiento crítico y la reflexión, al tiempo que fortalece su relación y aprecio por el suelo como un recurso vital para la vida diaria.

Tiempo: 20 - 25 minutos

Recursos: Muestra roca caliza, muestra de suelo, cartulina mediana, marcador delgado, lupa.

Metodología y pasos:

1. ***Introducción al suelo como amigo:*** Comenzar la actividad presentando el suelo como un amigo de los niños. Destacar cómo el suelo les brinda alimento y agua limpia, y cómo pueden ser agradecidos con el suelo al tomarse el tiempo de conocerlo mejor. Utilizar ejemplos relacionados con la amistad para que los niños comprendan la importancia de conocer mejor al suelo. Explicar que cuando desean ser amigos de alguien, quieren conocer más sobre esa persona y saber de dónde viene.
2. ***Observación roca caliza y muestra de suelo:*** Mostrar a los niños un ejemplar de roca caliza y una muestra de suelo. Permite que los niños interactúen con las muestras, tocándolas

y observándolas. Que puedan observar algunos de los pequeños organismos que viven en el suelo.

3. *Afirmación inicial y reglas para hacer preguntas:* Presentar la afirmación inicial que servirá como base para sus preguntas: "El suelo debajo de sus pies proviene de la roca caliza que están tocando". Luego, establecer cuatro reglas para la actividad:

   a. Hacer tantas preguntas como puedan.

   b. No detenerse a discutir, juzgar o responder a las preguntas.

   c. Anotar todas las preguntas exactamente como se formulan.

   d. Cambiar cualquier afirmación por una pregunta.

4. *Tiempo para hacer preguntas:* Dar a los niños 5 minutos para que hagan todas las preguntas que puedan sobre el suelo y anotarlas en una cartulina que se dará para todo el grupo. Animarlos a ser creativos y a explorar diferentes aspectos del suelo.

5. *Selección de las preguntas más importantes:* Una vez finalizado el tiempo, pedir a los niños que, como grupo, seleccionen las tres preguntas de su lista que consideren más importantes para conocer mejor a su amigo suelo. Animar a que justifiquen por qué escogieron esas preguntas.

6. *Cierre y reflexión*: Con base a las preguntas que los estudiantes seleccionaron, se explicará con sencillez qué es un suelo y qué ingredientes componen el suelo. Se mostrará un sencillo experimento para mostrar la erosión de las rocas (https://www.youtube.com/shorts/uj_PuURRd2Y) y hacerlo parte de su exploración, y enlazarlo con la explicación. Resaltar sobre todo la idea del suelo como un recurso no renovable por todo el tiempo que se tarda en formar. Mencionar brevemente qué cosas permite el suelo que podamos tener (su función). La metodología para la explicación se hará mayoritariamente con preguntas retóricas.

Actividad 3:

Breve descripción:

Con el propósito de evaluar si ha despertado curiosidad o interés en los niños el suelo, se puede proponer una actividad adicional donde los niños creen un dibujo o escriban una carta dirigida a

su "amigo el suelo". Utilizando lodo y colorantes comestibles, podrán explorar distintas tonalidades y texturas. Se les animará a ser creativos al decorar la tarjeta según sus preferencias, pero con la condición de incluir una pregunta que les gustaría hacerle a su amigo el suelo y una característica que les gusta de él. De esta manera, podrán expresar su curiosidad y desarrollar una conexión emocional con el suelo.

Además, al incluir una característica que les gusta del suelo, estarán promoviendo un sentimiento de aprecio y cuidado hacia este recurso vital.

Tiempo: 15 – 20 minutos

Recursos: Vasos de vidrio (yo tengo varios recipientes de vidrio que se pueden utilizar para mezclar el lodo con el colorante comestible), colorantes comestibles, pinceles (solo algunos pues igual pueden pintar con las manos), cartón o cartulinas gruesas, colbón (por si desea pegar hojas u otros elementos a su carta), tierra y agua.

Metodología y pasos:

1. ***Explicación de la actividad:*** Indicar a los niños que tendrán la oportunidad de crear un dibujo o escribir una carta dirigida a su "amigo el suelo". Explicar que utilizarán lodo y colorantes comestibles para explorar diferentes tonalidades y texturas. Destacar que el suelo es un amigo importante que nos provee de alimentos y agua limpia.
2. ***Distribución de materiales:*** Proporcionar a cada niño una hoja de papel, lodo y colorantes comestibles en diferentes tonalidades. Asegurarse de que tengan suficiente espacio para dibujar o escribir su carta.
3. ***Exploración del lodo***: Invitar a los niños a sumergir sus manos en el lodo y experimentar con su textura y consistencia. Animar su curiosidad y creatividad al explorar las posibilidades de mezclar colores y crear diferentes tonalidades con los colorantes.
4. ***Creación del dibujo o carta***: Invitar a los niños a utilizar el lodo y los colorantes para crear su dibujo o escribir su carta. Recordar que deben incluir una pregunta que les gustaría hacerle a su amigo el suelo y una característica que les gusta de él.

5. *Tiempo para finalizar:* Brindar a los niños un tiempo suficiente para que terminen sus dibujos o cartas. Asegurarse de que todos hayan completado la actividad antes de pasar a la siguiente etapa.

6. *Compartir y reflexionar:* Invita a los niños a compartir sus dibujos o leer sus cartas en voz alta. Fomentar la discusión y reflexión sobre las preguntas formuladas y las características que aprecian del suelo. Animar a los niños a expresar sus emociones y experiencias durante la actividad.

ANNEX 3. Additional photos Ecological Garden Workshop

Fotografías adicionales de la implementación de la actividad “Huerto Ecológico”:


LAS
PLANTA


SI SE
PUEDA


Gracias al suelo
Podemos


EL SUELO
PUEDO
PLANTAR


EN EL SUELO
PUDO
CAMINAR


MEDAS
PLANTAS
GRACIAS


GRACIAS POR
Poder CAM
NAT.

ANNEX 4. PequeIngeniería Workshop

TALLER PEQUEINGENIERÍA

Descripción:

En esta actividad interactiva y educativa, los niños tendrán la oportunidad de representar diferentes eventos que ocurrieron a lo largo de la historia de la Tierra. A través de un juego de roles, aprenderán sobre la escala de tiempo geológico y comprenderán la relativa brevedad de la existencia humana en comparación con la historia geológica del planeta.

Materiales necesarios:

- Un espacio amplio en el suelo
- Una línea de tiempo geológico de al menos 10 metros (o quizás más) de longitud dibujada en el suelo, con marcas cada metro (o cada 50 cm) para indicar la escala del tiempo.
- Tarjetas con imágenes y descripciones de eventos en la historia de la Tierra significativos.

Procedimiento:

Se hizo una breve introducción sobre el cumpleaños del planeta Tierra a todos los niños y luego se hicieron grupos. Se reunieron todos los grupos juntos y se les

1. ***Reunión de grupos***: Reunir a todos los grupos juntos y proporcionar a cada grupo una tarjeta representativa de un evento específico. Esto permitirá que todos los grupos trabajen con la misma información y participen en la discusión colectiva.
2. ***Discusión colectiva:*** Después de que cada grupo haya tenido tiempo suficiente para estudiar su tarjeta, fomenta una discusión grupal donde todos los grupos compartan y argumenten en qué lugar de la línea de tiempo debería ubicarse cada evento geológico.
3. ***Votación y consenso:*** Después de la discusión colectiva, pedir a los grupos que decidan en conjunto la ubicación de cada evento geológico en la línea de tiempo. Animar a los grupos a argumentar y persuadir a los demás para llegar a un consenso. Esto permitirá una mejor comprensión de la inmensidad del tiempo geológico a medida que los niños trabajen juntos para tomar decisiones basadas en diferentes perspectivas.
4. ***Posicionamiento en la línea de tiempo:*** Una vez que se haya alcanzado un consenso, colocar las tarjetas en la línea de tiempo según las decisiones tomadas por todos los grupos. Esto reflejará la colaboración y el consenso alcanzado por el conjunto de los participantes.

5. *Corrección y comparación:* Después de que todas las tarjetas estén colocadas en la línea de tiempo, corregir las posiciones para ubicarlas en los momentos correctos según la información geológica establecida. Realizar una comparación entre la línea de tiempo corregida y la línea de tiempo formada por los grupos. Destacar las diferencias y resaltar cómo la escala del tiempo geológico abarca millones y millones de años.

   Estos cambios permitirán una mayor participación e interacción grupal, lo que ayudará a los niños a comprender mejor la vastedad del tiempo geológico.

Beneficios educativos:

- Los niños desarrollarán una comprensión visual y tangible de la escala del tiempo geológico al interactuar directamente con la línea de tiempo en el suelo.
- A través del juego de roles, los niños se involucrarán activamente y aprenderán sobre eventos geológicos, fomentando su curiosidad y participación.
- La actividad promoverá la colaboración en equipo, el debate y la toma de decisiones conjuntas mientras los grupos discuten y llegan a un acuerdo sobre la ubicación de su evento asignado.
- Comparar la línea de tiempo formada por los grupos con la línea de tiempo correcta permitirá a los niños reflexionar

ANNEX 5. Qualitative assessment

EVALUACIÓN CUALITATIVA SITIOS DE GEODIVERSIDAD

Índice

NOMBRE SITIO	Ruinas del Castillo de Collado
LOCACIÓN GEOGRÁFICA	43° 24'12.19" N , 3° 53'28.42" O

PAISAJE Presenta un paisaje que refleja un poco de deterioro o descuido. Aunque ubicado en un entorno natural encantador, el sitio se ve afectado por la vegetación exuberante que ha crecido sin control. Desde el mirador designado, la vista panorámica se encuentra obstruida en gran medida por la densa vegetación circundante. Esto impide apreciar plenamente la belleza del paisaje que rodea las ruinas. Visualmente, el sitio no destaca por su espectacularidad y la vegetación que cubre gran parte de las ruinas añade una sensación de abandono.

POTENCIAL INTERPRETATIVO

A pesar de las limitaciones, el paisaje aún posee un potencial interpretativo interpretativo. A pesar de que las ruinas en sí puedan no ser especialmente espectaculares, se puede aprovechar para brindar información sobre las técnicas de construcción utilizados en la época, la vida en esos tiempos e interacciones históricas. Es posible resaltar la importancia de los materiales de construcción. (las rocas) ; pero aún así su potencial interpretativo no es muy alto en relación con la geología.

ACCESIBILIDAD

No es completamente accesible para todos los visitantes. El sendero cercano al sitio no está pavimentado y requiere caminar por un prado alto y sin cortar en su primera parte, lo que dificulta el paso. A lo largo del sendero, hay tramos donde es necesario agacharse debido al crecimiento excesivo de la vegetación. No apto para personas con movilidad reducida o que utilicen cochecitos de niños. Además, el terreno para caminar puede volverse un poco rocoso en ciertas partes, agregando un nivel de dificultad para la accesibilidad.

SEGURIDAD Puede representar un desafío para los visitantes. Como se mencionó antes, el sendero que lleva al castillo tiene una primera sección con un prado alto y denso, lo que dificulta caminar. El mirados que se encuentra en la cima está en buen estado y cuenta con una cerca sólida. Toca andar con cuidado pues la pradera alta cubre el suelo, dificulta la visibilidad de los canales del castillo, por lo que podría generar tropiezos o accidentes.

OTRAS OBSERVACIONES

Es un sitio público, pero una de las entradas al castillo ha sido cercada. Google maps muestra que es posible acceder al sitio por esa entrada pero al comprobar el sendero realmente no es posible (ver fotos). Por lo que esto puede llegar a confundir al turista y generar estrés y desanimo para visitar.

Ha de resaltar, en su valor cultural, el castillo es una fortaleza altomedieval cuyas ruinas, son el mejor ejemplo de este tipo de edificios militares en Cantabria.
Utilización del castillo → siglos ~ VIII – XI

NOMBRE SITIO	Dolina Pozón de la Ruperta
LOCACIÓN GEOGRÁFICA	43° 23'56.44" N 3° 53'22.57 O

PAISAJE

Es una hermosa depresión circular repleta de agua con tonalidades verdosas sugiriendo cierta contaminación.
La vegetación es exhuberante alrededor de la dolina, pero se ve afectada por el abandono de llantas y otras basuras. (Residuos humanos es evidente en el entorno. No obstante, el lugar mantiene un buen atractivo visual. También es notable la presencia de fauna alrededor, a pesar de condiciones adversas, se muestra la resilencia de la naturaleza. La belleza natural de la dolina se ve afectada por la acción humana.

POTENCIAL INTERPRETATIVO

El lugar es un testimonio histórico de la actividad minera de hierro que tuvo lugar a principios del siglo XX. Las características visuales como el contraste de la forma circular de la dolina con el entorno natural, el tono verdoso del agua puede ser un punto de interes que genere preguntas sobre la calidad del agua y ecosistema acuático. El lugar es una oportunidad de mostrar cómo la minería ha dejado su marca en el paisaje. Abre la oportunidad de educar a visitantes y comunidades locales sobre la historia de la minería de hierro en la región. Empezando por concientizar la razón por la cual fue necesario crear un lago artificial para el lavado de minerales. Esto fue porque al principio se extraía agua del subsuelo para el lavado, generando un gran problema de hundimientos. Por lo cual el pozón fue una de las soluciones. Desafío ambiental y práctica de conservación.

ACCESIBILIDAD

Fácil acceso.
Situado cerca de una vía principal. Presenta área para parquear coche. Desde el parqueadero hay un sendero marcado que lleva al pozo, asegurando una navegación fácil.

El sendero es plano, para individuos de todos los niveles de estado físico. Acceso para personas con mobilidad reducida? o necesidades especiales.

El camino hacia el sitio es lo suficientemente ancho para acomodar grupos de visitantes, sin embargo, ya más cerca del sitio la vegetación es más densa, disminuyendo la movilidad. Y no hay area de descanso, donde el visitante pueda admirar la belleza del lugar. Tampoco hay una señalización/pública

SEGURIDAD

Si bien el sendero hacia la dolina está bien delimitado y visible, no se observa ninguna estructura de seguridad alrededor de la dolina. Además, la densa vegetación alrededor del sendero requiere agacharse y estar atento para evitar accidentes. El parqueadero ofrece un lugar seguro para dejar los carros.

OTRAS OBSERVACIONES

Es un lugar público con un paisaje atrayente pero se observa que no es un lugar donde se haga un mantenimiento seguido pues presenta una vegetación exhuberante y con basura / llantas alrededor. Pareciera que por su abandono este lugar haya sido utilizado como vertedero.

NOMBRE SITIO	Cueva el Juyo
LOCACIÓN GEOGRÁFICA	43° 25' 52.65" N ; 3° 53' 25.75" O

PAISAJE

El sitio es un valle cerrado con un escenario de belleza natural. Con un aire de misterio se observa en la parte más baja del valle un puerta cerrada que da entrada a la cueva. Tiene una atmosfera serena y armoniosa. La belleza del entorno natural contrasta con las casetas llenas de grafitis y abandonadas. Además, en la cima se aprecia mejor el relieve del valle, y cuenta con una panorámica a la Bahía de Santander.

POTENCIAL INTERPRETATIVO

La presencia del desprendiento que se observa estando en la parte alta del valle da oportunidad para destacar la importancia de la conservación del patrimonio arqueológico y necesidad de proteger sitios históricos. Así como resaltar los efectos/riesgos que puede traer la intervención del hombre en este tipo de valles. También da oportunidad para recalcar la fragilidad del entorno natural, y necesidad de un enfoque sostenible y consciente hacia conservación del patrimonio. A pesar de ser una cueva prehistórica, el hecho de que no es apta para el público representa una limitación para la interpretación del lugar ya que cualquier elemento que se mencione de la cueva prehistórica no podrá ser observada directamente por el visitante.

ACCESIBILIDAD

El lugar es fácilmente accesible en coche, se puede llegar directamente en carro. El espacio para parquear es reducido. La accesibilidad en transporte público puede ser complicada, ya que las paradas de autobús no se encuentran muy cerca, así que el visitante que optaría por esta opción recorrería un largo tramo para acceder, lo que reduciría frecuencia de turistas.

SEGURIDAD

No se detecta mayores riesgos de seguridad. Es un entorno tranquilo, aunque el acceso a la cueva no está permitido y la puerta esta cerrada con llave, no existe una señalización en que se advierta el peligro de entrar por la cuenta del visitante. No sólo no se permite entrar por seguridad sino también por la conservación de la cueva.

OTRAS OBSERVACIONES

Es una área pública, donde en algún momento se descaba instalar un área recreativa (camping, bbq) y la obra fue detenida por denuncia de haber afectado hidrología del lugar. Se había modificado la dinámica fluvial de la cueva y se instaló una tubería para evitar que el valle se inundara. Adicionalmente, está declarado como un Área Natural de Especial Interés (ANEI).

NOMBRE SITIO	Cantera de Bilbao - Escuela de escalada
LOCACIÓN GEOGRÁFICA	43° 23'54.40"N ; 3° 54' 12.35" O

PAISAJE

El paisaje muestra una mezcla entre la intervención humana y la belleza natural. Las bancadas de piedra, perfectamente cortadas y alisadas para extraer los bloques, forman una visualización muy atractiva de la manera ordenada en que se explotó el recurso de roca caliza. La rehabilitación del entorno ha permitido que la vegetación del encinar intente recuperarse. Desde el mirador, se ofrece vista privilegiada del valle de Escobedo, revelando los montes calizos que lo bordean. Especialmente se aprecia muy bien la configuración del uso de la llanura, donde las viviendas ocupan cada vez más espacio.

POTENCIAL INTERPRETATIVO

El sitio puede ser utilizado para explorar la historia de la extracción de roca caliza (el cómo se extraían los bloques) y su importancia en la industria local. Incluyendo las pasadas técnicas de extracción que se implementaban anteriormente. También es posible resaltar cómo la rehabilitación de la cantera ha representado una mejora para el paisaje y algunos beneficios para la flora y fauna locales. Asimismo, la vista privilegiada a la llanura de Escobedo permite explicar la importancia y relevancia de los suelos especiales del valle al ser un Polje, pues son suelos especialmente fértiles. Lo anterior abre la oportunidad para concientizar sobre lo fundamental de los suelos para seguridad alimentaria de la sociedad. Por otra parte, el sitio permite destacar importancia entre patrimonio cultural y natural.

ACCESIBILIDAD

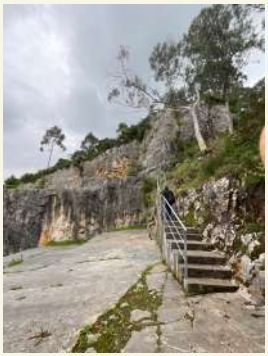
El acceso al sitio es fácil en coche y ofrece un buen espacio para parquear. Se encuentra ubicado frente a una vía principal, lo que hace más fácil tanto llegar con coche propio como con transporte público. La parada de autobus más cercana está a solo 6 minutos, haciendolo conveniente para el público que no tiene coche.

SEGURIDAD

A pesar de que se ha instalado infraestructura de seguridad como cercas en los acantilados, escaleras con pasamanos muy estables, existen ciertas zonas donde el sitio puede resultar riesgosa para los turistas. Estos riesgos potenciales no están debidamente señalizados o reconocidos, como el posible desprendimiento de bloques inestables de uno de los acantilados. También la construcción de unas escaleras al lado de la escombrera de la cantera, la cual puede ser muy inestable. Para mejorar la seguridad se podría sugerir colocación de señales de advertencia y restricción de acceso a ciertas zonas.

OTRAS OBSERVACIONES

Cantera de explotación "Piedra de Escobedo" - es una roca microcristalina, siendo muy dura y con planos de estratificación muy bien definidos. También hay una zona de deporte para escalar.



NOMBRE SITIO	Necrópolis e Iglesia de San Pedro
LOCACIÓN GEOGRÁFICA	43° 24' 17.53 N ; 3°53'58.85" O

PAISAJE

La iglesia de San Pedro, una estructura del Renacimiento, muestra un paisaje arquitectónico que transporta a las épocas comprendidas entre los siglos XV y XVII, reflejando el estilo renacentista y la estética de la época.
La necrópolis ha sido musealizada, las tumbas bajo el cristal incorpora un elemento intrigante y permite a los visitantes contemplar el patrimonio histórico y arqueológico de forma respetuosa.

POTENCIAL INTERPRETATIVO

En el sitio ya existe una interpretación que explora los detalles de la historia funeraria de la época y la historia de la arquitectura religiosa. Es posible acentuarse aún más en la relevancia de la Iglesia en el contexto cultural y religioso de la época, explorando más los rituales y las creencias asociadas con la necrópolis y su conexión con la iglesia como lugar de culto.
La relación más directa o evidente con la geología son los materiales de construcción de las tumbas e iglesia. Las lajas, por ejemplo, de las tumbas están hechas de cuarcitas o caliza. Aparte de este punto, no parece haber más conexiones. Adicionalmente, se puede continuar explorando aspectos como la estructura social, prácticas funerarias, jerarquías y vida cotidiana, para obtener visión más completa de la época.

ACCESIBILIDAD

El sitio presenta una buena accesibilidad, ubicado inmediatamente al lado de una vía principal. Esto facilita el acceso tanto en vehículo propio como en transporte público. De manera conveniente, existe un espacio de parqueo para dejar el coche de forma segura.

Para los visitantes sin coche y que opten por transporte público, la parada de autobús más cercana queda a 6 minutos caminando

SEGURIDAD

En general, la seguridad en el sitio no representa una preocupación significativa. Es un lugar tranquilo y sin consideraciones o riesgos de seguridad serios. Las tumbas, al estar debajo del cristal y cercadas, están protegidas y se evita el acceso no autorizado.

NOMBRE SITIO

Ruta circular en Peñas Negras; Del mirador de Gigüela a "Solo Frutales"

LOCACIÓN GEOGRÁFICA

Sendero ubicado en mayor medida al extremo sur del municipio de Santa Cruz de Bezana y en menor proporción ocupa un espacio de la parte Este del municipio de Camargo.

PAISAJE

El paisaje de estos montes es cautivador. En este entorno hay una gran variedad de especies vegetales que forman el exuberante bosque del Encinar. El ascenso hacia la cima ofrece panorámicas impresionantes de la zona, como vistas a la bahía de Santander y del valle de Escobedo. A lo largo del sendero hay algunas exposiciones de roca caliza, proporcionando un contraste visual con el verde del bosque. Adicionalmente, se aprecia una vista panorámica de una cantera bastante grande, resaltando la diferencia entre un paisaje natural y uno intervenido por la acción del hombre. De forma general, la caminata por este sendero de Peñas Negras representa una experiencia visualmente agradable y relajante, que dan una sensación de armonía y conexión con la naturaleza.

POTENCIAL INTERPRETATIVO

El potencial interpretativo del lugar es notable y diverso, donde es posible resaltar diversos aspectos de la naturaleza, incluyendo la geología conectada con la biodiversidad, también la historia minera y conservación. Es posible destacar el valor único de la presencia de encinares en la región, así como su relación con la roca caliza. Además, la presencia notable de estructuras como la dolina permite resaltar la capacidad "particular" de disolución de las rocas calizas que construyen el territorio. Estas estructuras, junto a los afloramientos de caliza ofrecen una oportunidad para explorar la geología de la región, haciendo visible los procesos geológicos que dieron forma al paisaje y cómo contribuye a la singularidad del sitio. Además, en la presencia de la *cantera* es posible explorar la importancia de la historia y el desarrollo social de este tipo de explotación de roca caliza en el área. Más aún, existen plantaciones de eucaliptos que representan un conflicto social en el área.

ACCESIBILIDAD

Es conveniente y fácil, tanto para los visitantes con coche como para los que opten por transporte público (aunque los buses no pasan muy regularmente). Desde el inicio de la ruta a la vía principal más cercana hay alrededor de 700 metros y todas las carreteras se encuentran pavimentadas. Aunque no hay un parqueadero específico sí hay un espacio donde dejar el coche de forma segura. Una vez estacionado el vehículo el recorrido del sitio se realiza a pie.
La parada de bus más cercana se encuentra a 10 minutos caminando del punto de partida de la ruta. Los anteriores detalles hace que en la experiencia de acceso no hayan complicaciones.

SEGURIDAD

La seguridad se puede considerar apropiada en general. Aunque sí sería optimo advertir mediante una señalización o similar que durante el verano se recomienda tener precaución y utilizar calzado adecuado debido al riesgo de encuentros con víboras, y recomendar caminar con atención por el sendero. La infraestructura del mirador en la cima es segura y estable, el sendero está bien señalizado. Adicionalmente, existen cercas en algunas partes del camino para delimitar el camino y mantener a los visitantes en áreas seguras. En general, la seguridad de los visitantes ha sido tomada en cuenta.

Resumen de justificaciones para la inclusión o exclusión en la Georuta

Basado en la evaluación cualitativa de los sitios, ciertas ubicaciones fueron excluidas de la georuta en el Valle de Escobedo por diversas razones. Las ruinas del Castillo de Collado no fueron consideradas principalmente debido a su difícil acceso, el sendero deteriorado que conduce al sitio, el potencial interpretativo geológico relativamente bajo y el aparente abandono y falta de gestión adecuada del lugar.

Por otro lado, a pesar de que la Dolina del Pozón de la Ruperta muestra evidencias de descuido y mala gestión, como basura y presencia de llantas abandonadas, cuenta con una excelente accesibilidad, amplio espacio para estacionar autos y un sendero bien cuidado y espacioso para acceder al sitio. Además, la información disponible sobre su legado histórico minero y su relación con los acuíferos tiene un valor significativo para el contexto local actual, lo que la convierte en una inclusión valiosa en la georuta.

La Cueva de El Juyo no fue incluida en la georuta debido a limitaciones en el acceso público a la cueva y la visibilidad de sus elementos geológicos más relevantes. Además, su considerable distancia con respecto a otros sitios de la georuta no justificaba su inclusión, ya que su valor no fue considerado excepcional para su incorporación. Además, el sitio parecía estar considerablemente abandonado y carecía de una adecuada administración.

Asimismo, la Necrópolis e Iglesia de San Pedro fueron excluidas de la georuta porque su potencial interpretativo no se integraba de manera efectiva en la narrativa prevista para la georuta. Además, su conexión con materiales de construcción, como arenisca o caliza, no reveló otros valores altamente relevantes para su incorporación. Su potencial interpretativo geológico desde una perspectiva holística era relativamente bajo, lo que llevó a la decisión de que su inclusión podría no ser de gran relevancia.

Por el contrario, la Cantera de Bilbao (escuela de escalada) fue incluida en la georuta principalmente debido a su facilidad de integración de interpretación con otros sitios cercanos de interés, la presencia de buenos espacios recreativos, el valor estético del paisaje y su alto potencial interpretativo.

Por último, el sendero de Peñas Negras, junto con el material educativo previamente disponible in situ, fue tenido en cuenta para la georuta, especialmente por su potencial para revelar las conexiones entre la geología, la biodiversidad y las actividades humanas. Además, su destacada estética del paisaje lo convirtió en una adición atractiva para la georuta.

ANNEX 6. Georoute interpretative contents in Spanish

CONTENIDOS GEORUTA VALLE DE ESCOBEDO

La siguiente georuta ofrece la posibilidad de realizar una visita autónoma al lugar, sin necesidad de guía, aprovechando un medio virtual que permitirá a los turistas o visitantes recorrer los sitios con su celular en mano y complementar lo que ven in situ con material proporcionado virtualmente. En este documento, nos enfocamos exclusivamente en los contenidos de la georuta, sin incluir el diseño visual o la forma en que se acompañará la información. En la Figura 1 se muestra el mapa de la georuta, con dos recorridos propuestos.

El primer recorrido, señalado en rojo en el mapa, se limita a la zona de Peñas Negras y se realiza exclusivamente a pie. Esta opción ofrece una experiencia agradable del entorno natural de Peñas Negras. Los visitantes tendrán la oportunidad de explorar aspectos destacados del paisaje y conocer uno de los fenómenos geológicos más relevantes de la zona.

Para aquellos que deseen una experiencia más enriquecedora y larga, se sugiere la posibilidad de extender el recorrido, marcado en amarillo en el mapa. Esta extensión incorpora dos paradas adicionales que permiten profundizar en temas relacionados con lo visto en la ruta de Peñas Negras y explorar otros aspectos específicos del paisaje.

Ruta 1 (color rojo):

Punto de partida: Parada de bus "La Jaya", Barrio de la Yasa, Maoño, Santa Cruz de Bezana.
Distancia total: 3 km
Altitud: 207 m
Desnivel: 132.5 m
Apto para carritos: No
Dificultad: Sencilla

Tiempo: 50 a 60 minutos

Transporte público:

Valdecilla Norte (Santander)– La Jaya (Santa Cruz de Bezana): Bus directo, ALSA-S5 Std-Mao, sin embargo, existen dos horarios, uno por la mañana y otro por la tarde.

Ruta 2 (extensión ruta 1 - color rojo y amarillo):

Punto de partida: Parada de bus "La Jaya", Barrio de la Yasa, Maoño, Santa Cruz de Bezana.
Distancia total: 6.2 km
Dificultad: Sencilla

Otras observaciones de transporte: Después de completar la primera ruta, existen dos posibilidades para continuar y llegar a la décima parada: si se cuenta con un coche, se puede optar por conducir; de lo contrario, la opción sería caminar 40 minutos, ya que no hay transporte público directo que conecte ambos lugares.

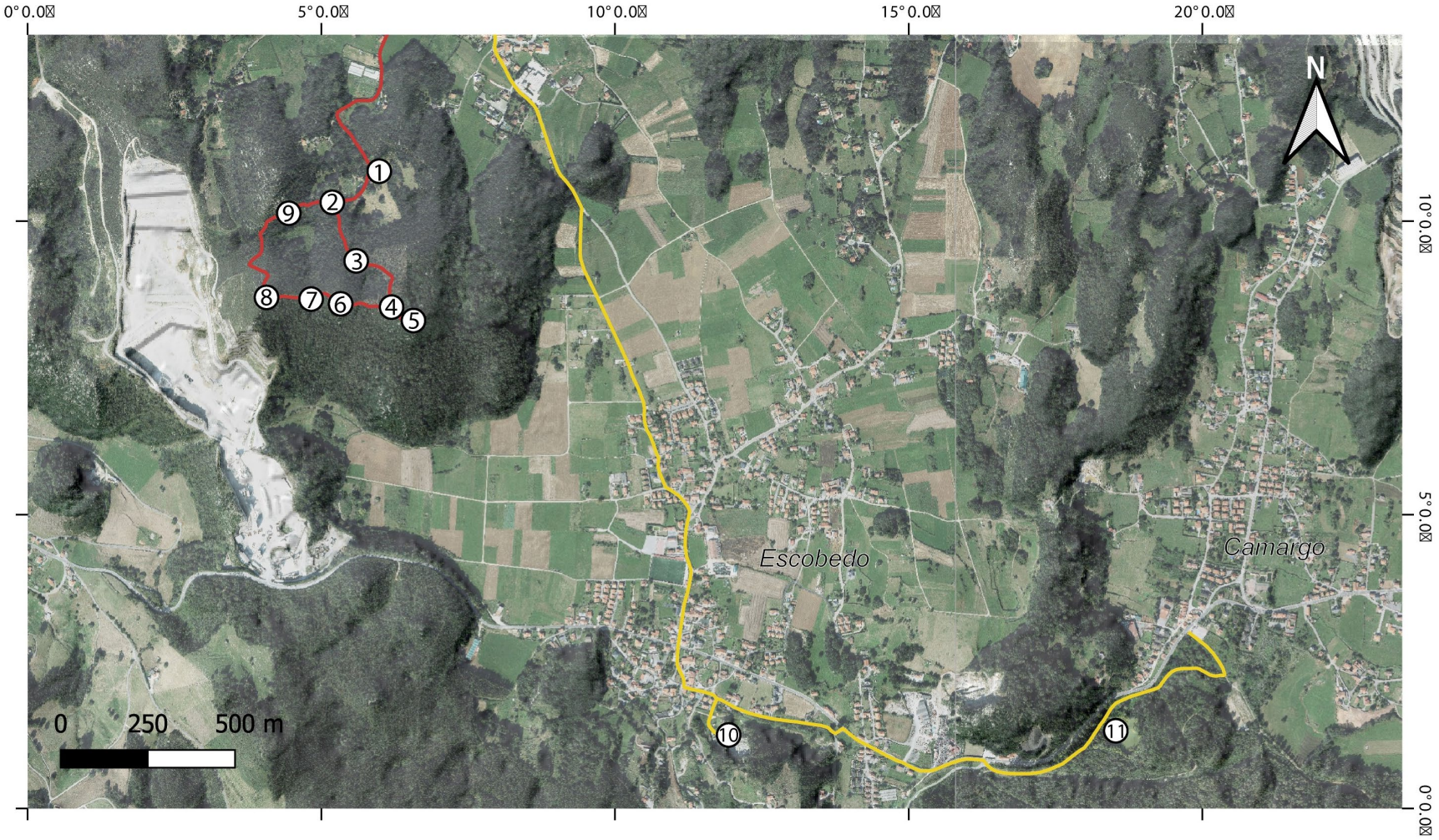


Figura 1. Mapa de la georuta con dos recorridos propuestos.

INTRODUCCIÓN A LA RUTA:

Idea clave:

Introducir y personificar los montes de Peñas Negras como un monte resiliente.

Objetivo emocional:

Se busca despertar la curiosidad, la empatía, la apreciación en el visitante.

Desafiando las apariencias: Las riquezas ocultas de Peñas Negras

"En el monte de Peñas Negras, hay mucho más de lo que se ve a simple vista. Los seres humanos, a veces juzgamos a las personas basándonos únicamente en su apariencia externa, sin tomar el tiempo necesario para conocer su interior. A veces nos pasa lo mismo con la naturaleza que nos rodea... Al igual que con las personas, solo cuando nos tomamos el tiempo de conocer su personalidad interior, podemos apreciar plenamente la joya y el valor único que poseen.

En esta georuta te invitamos a adentrarte en los Montes de Peñas Negras para descubrir su riqueza oculta y los desafíos que han enfrentado. A medida que camines por el sendero te sorprenderás al descubrir una belleza que va más allá de lo superficial.

Descubre la historia de resiliencia que tiene para contarte, observa con atención los detalles que revelan su personalidad y conéctate con la esencia profunda de la naturaleza. ¡Disfruta de tu viaje de descubrimiento!"

PRIMERA PARADA

Idea clave:

Las dolinas son formaciones geológicas similares a embudos que se originan por la disolución de rocas, en este contexto en rocas calizas.

Objetivo de aprendizaje:

Reconocer una dolina como una formación geológica en forma de embudo, comprendiendo su origen a partir de la disolución de rocas, particularmente en rocas calizas.

La Dolina: Un embudo natural en el paisaje

Observa atentamente el terreno... ¿notas esa formación circular hundida en el suelo? Esta estructura es conocida como dolina y revela la disolución de rocas en profundidad. En el interior del monte, se encuentran las rocas calizas, compuestas principalmente de carbonato de calcio. Estas rocas altamente solubles son el blanco perfecto para el asombroso proceso geológico que ocurre aquí, conocido como "karstificación".

Las rocas calizas se disuelven con el tiempo, creando cavidades subterráneas en la tierra. ¡Es como si el monte tuviera su propio mundo secreto bajo tierra! Pero la magia no termina ahí, cuando la cavidad alcanza un cierto punto, el techo colapsa y voilà, ¡una dolina nace!

Imagina un embudo gigante en la Tierra, como el que utilizamos en la cocina para verter líquidos. La dolina es justo eso, pero en una escala asombrosa. Actúa como una especie de capturador natural, canalizando el agua y otros elementos hacia el subsuelo. A medida que acerques la mirada al centro de la dolina, notarás cómo la tierra desciende en forma cónica, como el tubo estrecho del embudo.

Continúa la georuta para descubrir más sobre las fascinantes cualidades del maravilloso interior de Peñas Negras."

SEGUNDA PARADA

Idea clave:

El encinar y la roca caliza tienen una relación íntima, donde la presencia de la roca caliza influyó en la formación y el desarrollo del ecosistema boscoso del encinar.

Objetivo de aprendizaje:

Comprender y apreciar la estrecha relación entre el encinar y la roca caliza, reconociendo su importancia y comprensión de cómo la roca caliza influye en la sostenibilidad del ecosistema del encinar.

El Encinar de Peñas Negras: La Resilencia de la Naturaleza en un Entorno Cambiante

En este lugar único, la belleza superficial emerge de las rocas calizas, dando vida a un ecosistema boscoso donde predomina los árboles de encinas perennes conocidas como *Quercus ilex*.

La presencia de estos bosques en esta región siempre ha intrigado a los naturalistas que los han visitado en el pasado, pues persisten en un entorno tan distinto a su típico clima mediterráneo (cálido y árido). Cantabria, con sus abundantes lluvias y humedad, desafía las normas.

El encinar guarda una conexión especial con el pasado... Hace aproximadamente 2 millones de años el clima en la región de Cantabria era árido y se asemejaba a las condiciones del interior de la Península Ibérica. A medida que el clima evolucionó hacia condiciones más frías y húmedas, las especies vegetales tuvieron que adaptarse para sobrevivir. Se cree que las encinas (*Quercus ilex*) y otras especies buscaron refugio en enclaves más secos y cálidos. El encinar aprovechó las condiciones favorables que ofrecen las rocas calizas. Su capacidad para filtrar el agua y limitar la formación de suelo imitó las condiciones más secas y cálidas del pasado. Así es como la roca caliza se convierte en un aliado crucial para el encinar. Además, este enigma nos invita a reflexionar sobre cómo la naturaleza encuentra soluciones ingeniosas para sobrevivir.

Adéntrate en Peñas Negras y contempla el testimonio vivo de la resiliencia natural. Explora las maravillas de este encinar y déjate inspirar por su capacidad para adaptarse, resistir y florecer en un entorno en constante cambio. ¡Prepárate para ser testigo de la tenacidad y belleza que la naturaleza puede ofrecer!

TERCERA PARADA

Idea clave:

Los acuíferos desempeñan un papel esencial en el ecosistema y en el sostenimiento del territorio local al mantener el equilibrio hídrico.

Objetivo de aprendizaje:

Comprender la importancia crucial de los acuíferos para el bienestar y la sostenibilidad del territorio, reconociendo su íntima relación con las aguas superficiales que abastecen de agua a la población.

En lo Profundo de Peñas Negras: Un Tesoro Subterráneo

En el interior de Peñas Negras se esconde un verdadero tesoro: ¡un acuífero! Justo debajo de tus pies en este momento, existe un reservorio natural de agua. ¿Pero cómo es posible que haya agua debajo del suelo? Las rocas subterráneas aquí son muy solubles, y el agua, a lo largo de miles o incluso millones de años, ha creado asombrosas cavidades subterráneas en la roca caliza. Imagina la fuerza del agua moldeando estas maravillas bajo nuestros pies.

A medida que el agua fluye y se filtra a través de las grietas y poros de la roca caliza, se forman acumulaciones de aguas subterráneas, conformando este valioso acuífero.

Podemos pensar en las cavidades subterráneas del acuífero en regiones de rocas caliza como las tuberías en una casa, permitiendo que el agua se desplace y se almacene en diferentes lugares. Estas aguas subterráneas están íntimamente conectadas con los ecosistemas fluviales costeros del Río Pas y la Ría de Boo-Bahía de Santander, ya que son las que mantienen el caudal de estos ríos.

De hecho, el Río Pas es la principal fuente de suministro de agua para la ciudad de Santander, abasteciendo los depósitos de agua urbanos de la ciudad.

Así es como vemos que las aguas superficiales están estrechamente conectadas con las aguas subterráneas, que representan el 22% del total de agua dulce del planeta y constituyen la mayor reserva de agua dulce accesible. Por eso, los acuíferos son un tesoro para nuestro planeta.

Pero su importancia va más allá, ya que todo lo que afecta a un acuífero tiene repercusiones en el ciclo hidrológico en su conjunto. Además, los acuíferos son una reserva a largo plazo que garantiza el suministro de agua durante emergencias, sequías y cambios climáticos.

Cuidar y proteger los acuíferos es esencial para mantener nuestro suministro de agua dulce y preservar los ecosistemas acuáticos que dependen de ellos.

CUARTA PARADA

Idea clave:

Datos interesantes obre las plantas y frutos que florecen en Peñas Negras, apreciando su diversidad y las historias interesantes que las rodean.

Objetivo de aprendizaje: Apreciar la diversidad de los frutos/plantas que se dan en Peñas Negras y conocer las historias fascinantes que hay detrás de ellos.

Objetivo emocional: Despertar emociones positivas, como el asombro, la admiración y la curiosidad, al explorar las maravillas de las plantas en Peñas Negras, creando una conexión emocional con la naturaleza y el entorno.

¡El secreto del sabor de los mejores jamones Ibéricos!

La bellota, fruto de la encina y otras especies de Quercus, son el alimento preferido de los cerdos ibéricos y es la clave para el sabor excepcional del jamón de bellota 100% ibérico. Esta dieta saludable enriquece la carne con ácidos grasos insaturados, convirtiéndola en una opción cardiosaludable. Los cerdos se alimentan de bellotas durante el periodo de engorde, ganando hasta **50 kilos en dos meses** gracias a las propiedades nutricionales de este manjar.

¡Cuidado con el madroño!

Sus irresistibles bayas tienen un alto contenido de alcohol, por lo que tomar solo una de ellas podría hacerte sentir los efectos de su embriagante secreto. De hecho, los cazadores esperaban que fueran ingeridas por aves para dificultar su vuelo y poder capturarlas más fácilmente. Un fruto que cautiva tanto a las aves como a los aventureros valientes.

El Espino: Un Oasis de Protección y Vida

Los arbustos de Espino no solo proporcionan frutos sabrosos, sino que también ofrecen refugio y protección a una variedad de especies de aves y pequeños mamíferos. Sus densos y espinosos arbustos (de ahí su nombre) son ideales para anidar y resguardarse de los depredadores, convirtiendo al Espino en un valioso ecosistema en sí mismo.

Frutos para los valientes

Aunque los frutos azules del endrino son comestibles, su sabor ácido y astringente hace que sean más adecuados para su uso en bebidas y preparaciones culinarias, como licores, mermeladas y postres. Los entusiastas de los sabores fuertes y atrevidos encontrarán en el endrino un desafío culinario emocionante.

La Zarza en Acción: Turiones que Desafían la Gravedad

Durante la primavera, la zarza muestra un fenómeno fascinante. Sus turiones, que son brotes jóvenes y flexibles, operan como exploradores, buscando activamente el soporte adecuado para su crecimiento. Aunque el movimiento es imperceptible a simple vista, los turiones pueden crecer hasta cinco centímetros diarios, demostrando una capacidad de adaptación y expansión notable.

Ingrediente de la primera bebida de cola

Antes de la aparición de las colas comerciales modernas, se elaboraba una bebida refrescante muy consumida en Europa y América a base de las raíces de la zarzaparrilla, azúcar, miel y agua. La zarzaparrilla fue utilizada en la primera bebida de cola del mundo.

QUINTA PARADA

Idea clave:

Este paisaje desafía la comprensión debido a su origen en el relieve kárstico, siendo considerado uno de los más controvertidos.

Objetivo de aprendizaje: Apreciar la asombrosa singularidad del valle de Escobedo como un relieve kárstico. Conocer la controversia en torno a su origen.

¡Disfruta de una vista panorámica privilegiada del valle de Escobedo desde este punto, admirando los majestuosos montes vecinos de Peñas Negras! Este paisaje es conocido como "polje" por los científicos, una palabra que significa "campo" o "terreno" en esloveno. Su origen exacto continúa siendo un misterio para los expertos y es considerado el paisaje kárstico más enigmático de las regiones templadas.

Una teoría propone que este valle se formó a partir de la unión gradual de dolinas, creando una depresión tan vasta como el asombroso paisaje que tienes frente a ti. Imagina este valle como una gigantesca dolina, el colapso progresivo del techo de una cueva de proporciones épicas. ¿Quién podría haber imaginado la existencia de cavidades subterráneas de tales magnitudes?

Sin embargo, el monte de Peñas Negras demostró su resistencia y fortaleza al no colapsar y evitar convertirse en parte de la llanura del valle. Este precioso monte nos muestra su durabilidad y tenacidad frente a los cambios geológicos. ¡Admira la grandeza de la naturaleza en este magnífico lugar!

SEXTA PARADA

Idea clave:

Resaltar la capacidad de disolución de la roca caliza. La formación de la roca caliza.

Objetivo de aprendizaje: Explicar la solubilidad de la roca caliza y su formación en la zona.

Objetivo emocional: Provocar una reacción emocional positiva en el visitante, despertando su curiosidad y maravilla ante los procesos geológicos.

Los fragmentos de roca caliza frente a ti son una ventana directa al interior de Peñas Negras, y van más allá de simples pedazos de piedra. Sumérgete en una de las fascinantes características del interior de Peñas Negras: su capacidad de disolución.

Experimenta con el jugo de limón y la roca caliza:

¡Realiza tu propio experimento! Exprime el jugo de limón sobre la roca caliza y observa cómo reacciona. Verás cómo el ácido cítrico del limón desencadena una reacción química. La roca caliza se disolverá lentamente, revelando su sorprendente capacidad de reaccionar ante sustancias ácidas.

Recomendaciones: Para una reacción más notable, busca una porción de roca caliza menos meteorizada, sin tonos grises claros o amarillos. También puedes frotar dos trozos de roca caliza entre sí para exponer una superficie fresca antes de exprimir el limón. ¡Anímate a probar diferentes lados y fragmentos de roca!

¿Por qué la roca caliza se disuelve?

La roca caliza está compuesta principalmente de carbonato de calcio. Su naturaleza química única le permite disolverse en presencia de ácidos como el ácido cítrico. Esta disolución lenta a lo largo del tiempo es la clave para la formación de cuevas y otras formas geológicas fascinantes que puedes encontrar en esta área. ¡En la naturaleza, este fenómeno puede tardar millones de años!

¿Cómo se formaron las rocas calizas?:

Las rocas calizas son testimonio de un pasado donde el lugar en el que caminas estaba cubierto por un océano hace aproximadamente 115 millones de años, cuando la distribución de continentes y océanos en el planeta era diferente a la actual. Se forman en el fondo marino a medida que los corales y animales marinos con conchas se acumulan con el tiempo, convirtiéndose en una roca dura bajo su propio peso. Es por esto que, a veces, puedes encontrar fósiles en las rocas calizas, restos de plantas y animales que vivieron hace mucho tiempo. Te animamos a explorar con cuidado entre los escombros de roca caliza en busca de sorprendentes fósiles. ¡Hay una historia presente en cada fragmento!

SEPTIMA PARADA

Idea clave:

La plantación de eucaliptos fue una amenaza para el ecosistema de Peñas Negras.

Objetivo de aprendizaje: Comprender que las plantaciones extensas de eucaliptos son perjudiciales para el equilibrio del ecosistema, ya que desplazan a las especies autóctonas y afectan la biodiversidad.

Objetivo emocional: Despertar frustración y luego esperanza por el monte al comparar la problemática de los eucaliptos con una enfermedad cancerígena.

El cáncer de piel es una condición en la que células anormales crecen en los tejidos de la piel humana. Ahora, imagina que la cobertura vegetal del macizo rocoso de Peñas Negras es como la piel de este lugar. En este caso, el macizo de Peñas Negras sufrió una enfermedad similar cuando se introdujeron plantaciones de eucaliptos, árboles originarios de Australia y que se pueden considerar como "anormales" en esta región.

Te preguntarás, ¿por qué se plantaron árboles no nativos en Cantabria? La respuesta es sencilla: el eucalipto es un cultivo rentable utilizado para la producción de papel y cartón, entre otros productos industriales. Su rápido crecimiento y capacidad de generar madera lo hacen atractivo desde el punto de vista económico. Sin embargo, esta decisión tiene consecuencias en los ecosistemas locales.

Al talar los árboles autóctonos para dar paso a los eucaliptos, se produjo un desequilibrio en el bosque mixto característico de la zona. Las plantaciones masivas de eucaliptos pueden considerarse especies invasoras, ya que compiten con las especies nativas, liberan sustancias químicas que inhiben el crecimiento de otras plantas y sus frutos no son atractivos para la fauna local, alejándola del bosque.

Afortunadamente, esta enfermedad pudo ser controlada a tiempo. La Fundación Naturaleza y el Hombre intervino para "extirpar" progresivamente los eucaliptos y reemplazarlos por vegetación autóctona, aunque aún quedan algunos árboles de eucalipto. Peñas Negras demostró una vez más su resistencia y capacidad de recuperación.

Recuerda que, al visitar este lugar, eres testigo de la increíble capacidad de la naturaleza para recuperarse y renovarse.

OCTAVA PARADA

Idea clave: La roca caliza es un recurso valioso tanto para la biodiversidad como para la sociedad moderna, pero es importante considerar su impacto ambiental, especialmente en los acuíferos.

Objetivo de aprendizaje: Crear conciencia sobre el papel del uso de la roca caliza en nuestra sociedad y destacar su impacto negativo en los acuíferos.

Objetivo de comportamiento: Fomentar acciones conscientes en la vida cotidiana que puedan afectar a los acuíferos.

La explotación de la roca caliza bajo la lupa: ¿riqueza o desastre ambiental?

La cantera que se puede observar en este punto nos revela cómo se vería el interior de Peñas Negras, pone al descubierto la roca caliza. Este material no solo ha demostrado ser de gran valor para la biodiversidad sino también para la sociedad moderna, ofreciendo una amplia gama de usos y servicios (construcción, productos químicos y agrícolas).

Una roca con encanto: resistencia, durabilidad y elegancia

La roca caliza de esta región no es solo una piedra común. Es altamente valorada a nivel nacional debido a su resistencia, durabilidad y su estética elegante y rústica. Se le conoce popularmente como “Piedra de Escobedo”. Ha dejado su huella en impresionantes construcciones, como el Instituto de la Casa de Correos, el Palacio de la Magdalena y el Banco de España en la ciudad de Santander.

Un equilibrio frágil: cuidemos nuestro entorno natural

Si bien la extracción de roca caliza ha traído beneficios sociales, es crucial tener en cuenta el impacto en el medio ambiente. La extracción debe realizarse siguiendo buenas prácticas medioambientales, para evitar que agentes contaminantes pueden ser liberados al suelo o al subsuelo y luego migrar hacia nuestros preciados acuíferos, incluyendo el de Peñas Negras, afectando todo el sistema hídrico de la región y poniendo en peligro la vida silvestre que depende de ellos y a nosotros mismos. Es un delicado equilibrio natural.

La huella antrópica en el paisaje: nuestro papel como guardianes

En esta vista panorámica del paisaje, es interesante resaltar dos aspectos clave. Por un lado, los recursos geológicos brindan valiosos servicios a la sociedad, permitiendo la conservación del patrimonio natural y, al mismo tiempo, pueden llevar a su pérdida si no los gestionamos de manera sostenible. Por otro lado, observamos cómo el ser humano tiene la capacidad de modificar el paisaje y crear nuevas morfologías, dejando una huella antrópica en nuestro entorno.

Cada acción cuenta: sé un guardián de nuestros acuíferos

Tú también puedes marcar la diferencia en tu vida cotidiana. Piensa dos veces antes de desechar desechos peligrosos en el desagüe o en el suelo. Al hacerlo, puedes evitar la contaminación del suelo, el agua subterránea y las aguas superficiales cercanas. ¡Asegúrate de desechar adecuadamente medicamentos, aceites y productos químicos! Incluso algo tan simple como no arrojar basura al suelo contribuye a proteger nuestros valiosos acuíferos.

NOVENA PARADA

Idea clave: Mostrar las relaciones entre las aves páridos y el entorno de Peñas Negras, destacando curiosidades sobre estas aves.

Objetivo de aprendizaje: Mostrar las conexiones entre las aves pardelas y el entorno natural de Peñas Negras.

Objetivo emocional: Despertar emociones positivas como el asombro, la admiración y la curiosidad.

Aves Páridos: los jardineros voladores de Peñas Negras

Imagina que tienes un gran jardín lleno de flores hermosas, pero de repente aparecen plagas de pequeños insectos que amenazan con destruir toda la belleza del lugar. Se necesitaría un equipo de jardineros que se encargara de proteger y mantener ese hermoso jardín.

En Peñas Negras, ocurre algo similar. Las aves que habitan este monte son como jardineros voladores. Desempeñan un papel crucial en el ecosistema al controlar las plagas de insectos que podrían causar un desastre ambiental. Estas aves, como expertos "exterminadores" naturales, se alimentan de los insectos y los mantienen bajo control.

Pero eso no es todo, estas aves también desempeñan un papel importante en la dispersión de semillas. Mientras se alimentan de los frutos de los árboles y arbustos, las semillas pasan a través de su sistema digestivo y son excretadas en diferentes lugares. Esto contribuye a la propagación de las plantas y ayuda a mantener la diversidad y la salud del bosque.

¡Son jardineros jardineros voladores idóneos! pues colaboran con el ecosistema al controlar las plagas y ayudar en la reproducción de las plantas. Su presencia en Peñas Negras es esencial para mantener el equilibrio natural y preservar la biodiversidad de este maravilloso entorno.

Entre las aves que habitan este ecosistema están el herrerillo común (*Cyanistes caeruleus*), el carbonero común (*Parus major*), el herrerillo capuchino (*Lophophanes cristatus*) y el carbonero garrapinos (*Periparus ater*).

Conoce a estas protagonistas que destacan en el entorno natural...

Estas aves son famosas por su extraordinaria agilidad y habilidad acrobática. Observar cómo se cuelgan de las ramas y realizan movimientos rápidos y precisos mientras buscan alimento es un espectáculo impresionante.

Además de su gracia en el vuelo, estas aves destacan por su inteligencia y capacidad de aprendizaje. Estudios científicos han demostrado su habilidad para resolver problemas, incluso aprendiendo a abrir tapas para obtener alimento. Su rápida capacidad de aprendizaje y su variedad de estrategias para obtener alimento las convierten en especies fascinantes para observar.

CONCLUSIÓN/INTERMEDIO

Ideas clave:

-La roca caliza en Peñas Negras es fundamental como base del ecosistema, embellece el monte y actúa como reservorio de agua dulce para los manantiales y ríos que abastecen nuestras vidas cotidianas.

-Resumir las dificultades por las que ha atravesado el monte, mencionadas durante la georuta.

-Necesidad de cuidar y valorar Peñas Negras como una forma de cuidarnos a nosotros mismos, reconociendo que nuestra conexión con la naturaleza es esencial para nuestro bienestar a largo plazo.

Objetivo emocional: Generar admiración, empatía y compasión por el Macizo de Peñas Negras y apreciar la belleza de la naturaleza biótica y abiótica.

Objetivo de comportamiento: Comprometerse a un consumo más sostenible, evitar la contaminación del suelo y respetar el territorio.

Peñas Negras: Un legado de generosidad y conexión

En nuestra georuta por Peñas Negras, hemos sido testigos de la intrincada interconexión de la naturaleza y el valor inmenso que la roca caliza aporta como su firme base. Esta roca no solo

embellece y construye este monte, sino que también sirve como reservorio de agua dulce, sosteniendo los manantiales y ríos que abastecen nuestras vidas cotidianas al abrir el grifo de nuestras casas. ¡Qué regalos tan valiosos nos permite tener la presencia de la roca caliza que adorna y edifica Peñas Negras!

Más aún, hemos presenciado la admirable resiliencia de la naturaleza en Peñas Negras. Enfrentando desafíos como el cambio climático y las condiciones adversas, los encinares de la región han demostrado su tenacidad al adaptarse y encontrar estrategias para sobrevivir. Aprendemos de la naturaleza que siempre encuentra la forma de prevalecer, aunque también es evidente que necesita tiempo para sanar y recuperarse.

Tomemos como ejemplo la pandemia del COVID-19, que nos mostró cómo la naturaleza renace cuando se le da un respiro del impacto humano. Sin embargo, a menudo nos centramos en beneficios inmediatos y no consideramos las consecuencias a largo plazo. Así como el consumo excesivo de comida chatarra afecta nuestra salud a largo plazo, la explotación desmedida de los recursos naturales, como la plantación de eucaliptos y la extracción continua de roca caliza en las canteras, tiene un impacto negativo en el entorno natural y en por ende en la sociedad.

Peñas Negras ha soportado estos desafíos con valentía y resistencia. A pesar de las dolencias que le hemos impuesto, también hemos intentado mitigar los impactos y ahora es una reserva bajo protección.

Nos brinda un paisaje maravilloso, un aire limpio... es un monte diseñado para dar, y en respuesta, debemos cuidarlo y valorarlo. Al conectarnos con la esencia de Peñas Negras y disfrutar de su presencia, podemos honrar su generosidad y responder de la misma manera.

Peñas Negras nos invita a reconocer que nuestra conexión con la naturaleza no solo se basa en su belleza y espectacularidad intrínseca, sino que también es esencial para nuestro propio bienestar a largo plazo. Al cuidar y preservar este monte resiliente, nos cuidamos a nosotros mismos.

A medida que nos despedimos del monte, llevemos consigo el amor y la gratitud hacia Peñas Negras, comprometiéndonos a proteger y disfrutar de su magnificencia.

¡Te invitamos a continuar tu exploración por otros dos sitios que detallan aún más los temas abordados en tu recorrido por Peñas Negras! Descubre por qué el suelo del valle de Escobedo es tan especial y cómo la sobreexplotación de acuíferos ha afectado nuestro territorio.

DÉCIMA PARADA

Idea clave:

El suelo del valle de Escobedo es especial y es un recurso no renovable.

Objetivo de aprendizaje: Reconocer que el suelo del valle de Escobedo es especialmente fértil y comprender que su pérdida debido a la construcción de viviendas es irreversible.

Descubre la fertilidad especial de la llanura de Escobedo

Desde este mirador privilegiado, podrás admirar la inigualable llanura de Escobedo y descubrir una de sus joyas naturales más preciadas: sus suelos excepcionales que hacen este lugar extraordinariamente fértil.

El suelo de la llanura la componen arcillas de descalcificación, que provienen de la desintegración, y erosión de la roca caliza. Son especialmente fértiles debido a varias razones:

- Retención de agua: Las arcillas tienen una alta capacidad para retener agua y nutrientes, proporcionando un suministro constante para el crecimiento de las plantas. Cuanto más saludable es el suelo, mejor será la cosecha.
- Nutrientes esenciales: Estas arcillas contienen minerales y nutrientes esenciales para las plantas, como calcio, potasio y magnesio. Estos nutrientes se liberan lentamente a medida que las arcillas se descomponen, brindando un suministro constante de nutrientes para las plantas.
- pH equilibrado: Las arcillas de descalcificación tienen un pH casi neutro o ligeramente ácido, lo que favorece el desarrollo de las raíces y la absorción de nutrientes por parte de las plantas.
- Estructura del suelo: Estas arcillas mejoran la estructura del suelo al aumentar su capacidad de retención de agua y nutrientes, permitiendo un mejor desarrollo de las raíces y una mayor disponibilidad de nutrientes para las plantas.

Perdiendo el suelo, perdiendo nuestro futuro: la amenaza silenciosa bajo nuestros pies

El suelo es un recurso valioso pero limitado. No se regenera a una velocidad suficientemente rápida para su uso continuo. De hecho, se estima que la Tierra tarda aproximadamente 1000 años en generar tan solo 1 cm de suelo. Esto significa que, si hoy hicieras un hueco en el suelo, podrían pasar alrededor de 40 generaciones en tu árbol genealógico antes de que ese lugar vuelva a tener 1 cm de suelo nuevo.

Según un informe de la ONU en 2019, cada año se pierden 24.000 millones de toneladas de suelo fértil en todo el mundo, lo cual es una preocupación apremiante.

En la llanura de Escobedo, contamos con suelos excepcionales que son fundamentales para la producción de alimentos. Cada área de suelo perdida para la construcción de viviendas significa una pérdida de potencial para cultivar alimentos y garantizar nuestra seguridad alimentaria a largo plazo. La llanura de Escobedo es un tesoro de fertilidad especial que es importante proteger para asegurar un futuro sostenible.

¡Aprovechemos esta oportunidad para valorar y cuidar nuestros suelos, y así garantizar la prosperidad y el bienestar de las generaciones venideras en la Llanura de Escobedo!

ONCEAVA PARADA:

Idea clave:

La sobreexplotación de acuíferos conlleva graves problemas sociales y económicos.

Objetivo de aprendizaje: Comprender que desequilibrar la explotación de acuíferos no es una medida sostenible a futuro.

Aguas agotadas, tierra frágil: lecciones de un pasado minero

El Pozón de la Ruperta es un lago artificial testimonio del pasado minero de Camargo. En el pasado, la empresa minera "Bairds Mining Company Ltd." extraía mineral de hierro a cielo abierto. En su proceso de lavado y extracción del mineral, utilizaron grandes cantidades de agua extraída de los acuíferos subterráneos a través de pozos y bombas. Sin embargo, esta práctica tuvo consecuencias sociales y económicas.

Cuando el agua agota la tierra: los efectos destructivos de la extracción desmedida

La extracción excesiva de agua de los acuíferos debilitó la estructura del terreno y provocó el colapso del suelo. Los hundimientos resultantes, conocidos como "soplaos", pusieron en riesgo la seguridad de los ciudadanos y sus propiedades.

Cambiando la estrategia

Como respuesta a esta problemática, la empresa minera decidió aprovechar una depresión del terreno, la dolina, para crear el Pozón de la Ruperta. Taparon el sumidero de la dolina y la impermeabilizaron, convirtiéndola en un lago artificial.

Lecciones Aprendidas

La historia del Pozón de la Ruperta nos enseña la estrecha relación entre la extracción de agua del subsuelo y las consecuencias en la estabilidad del terreno. La sobreexplotación de los acuíferos puede comprometer la seguridad de las comunidades y generar problemas económicos a largo plazo. Por lo tanto, es fundamental comprender que la sobreexplotación de los acuíferos no es una solución eficiente ni sostenible.

ANNEX 7. Didactic Guide for teachers

GUÍA DIDACTICA PARA DOCENTES

Descubriendo el dinamismo de la Tierra en un paisaje kárstico

Nivel educativo: 1º ESO (Educación Secundaria Obligatoria-Niños de 12 a 13 años)

Lugar: Valle de Escobedo (municipio de Camargo)

Contenidos:

- ✓ La Tierra es un planeta en constante cambio y movimiento.
- ✓ Agentes que dan forma al relieve terrestre, tanto internos como externos.
- ✓ El papel significativo del ser humano en la modificación del entorno natural.
- ✓ El agua como agente modelador en la formación del relieve karst, incluyendo la creación de acuíferos y la explotación de estos recursos.

Objetivos generales:

- ✓ Comprender la naturaleza dinámica de la Tierra como planeta, reconociendo los diversos agentes que moldean el relieve terrestre a lo largo del tiempo.
- ✓ Destacar la relevancia del agua como un agente fundamental en la formación y modelado del paisaje.
- ✓ Analizar de manera específica el paisaje kárstico presente en su entorno local y su relación con la acción del agua como modelador del terreno.

Objetivos específicos:

1. Comprender la dinamicidad de la Tierra.
2. Reconocer y diferenciar los distintos agentes que contribuyen a la configuración del relieve terrestre.
3. Analizar el tipo de relieve predominante en su entorno escolar, en el municipio de Camargo.
4. Adquirir conocimientos sobre la distribución del agua dulce en el planeta y la importancia de las aguas subterráneas en su territorio local.

Actividad Pre-Campo

Fomentando la curiosidad con el Método QFT

(Question Formulation Technique; En español: *Técnica de formulación de preguntas*)

Las preguntas son herramientas de aprendizaje extraordinarias, esenciales para el desarrollo intelectual y personal, ya que promueven el pensamiento crítico, aumentan la confianza y fomentan una mentalidad de aprendizaje continuo. La curiosidad desempeña un papel fundamental en el fomento del aprendizaje, y es un aspecto necesario en la implementación del método QFT (Question Formulation Technique; https://rightquestion.org/what-is-the-qft/); de hecho, sin curiosidad, el método no puede llevarse a cabo.

El método QFT es una valiosa herramienta que permite a los alumnos conocer respuestas a preguntas que ellos mismos generaron, en lugar de únicamente recibir respuestas sobre temas que quizás no les interesaba conocer. Al brindarles la oportunidad de formular sus propias preguntas a partir de una premisa, este método potencia su habilidad de hacer y mejorar sus preguntas, ayudándolos a profundizar en la comprensión de un tema específico. Antes de la salida de campo al paisaje kárstico de Camargo, se utilizará este método para motivar el aprendizaje durante la visita.

La actividad parte de la presentación de un estímulo llamado "QFocus", que puede ser una declaración, imagen u otro elemento relacionado con el tema a explorar. En este caso se sugiere al docente el “QFocus” expuesto en la Figura 1, pero puede diseñar el que mejor se adapte a sus necesidades. Ya habiendo preparado y diseñado el “QFocus”, se pueden seguir en el aula los siguientes pasos:

Paso 1: Presentación del método QFT y formación de grupos

- Introducir a los estudiantes qué es la Técnica de Formulación de Preguntas y cómo puede ayudarnos a descubrir más sobre el paisaje. Luego, dividir a los estudiantes en grupos pequeños para fomentar la colaboración y el intercambio de ideas. Cada grupo recibirá una cartulina mediana donde se escribirán las preguntas que surjan entre los participantes del grupo después de que se presente el QFocus en el paso 3.

Paso 2: Exposición de las reglas

- Los alumnos seguirán cuatro reglas esenciales para producir preguntas: hacer tantas preguntas como puedan en un tiempo determinado, no detenerse a discutir o responder las preguntas, anotar cada pregunta tal como se formula y convertir declaraciones en preguntas.

Paso 3: Presentar el QFocus y generar preguntas

- Mostrar el QFocus sin dar demasiada explicación de él. Los estudiantes harán una lista de preguntas basadas en el QFocus y numerarán cada pregunta para identificarlas claramente.

Paso 4: Mejorar las Preguntas

- Los grupos trabajarán con las preguntas que han generado y las clasificarán. Escribirán una 'c' al lado de la pregunta si es una pregunta cerrada o una 'a' si es una pregunta abierta. Es importante destacar que el docente se habrá asegurado con anterioridad de que los estudiantes comprendan qué es una pregunta cerrada o abierta.
- Discutir las ventajas y desventajas de ambos tipos de preguntas.
- Cambiar preguntas de un tipo a otro para ampliar la perspectiva.

Paso 5: Selección de Preguntas Clave

- Cada grupo seleccionará las tres preguntas más importantes que deseen responder durante y después de la visita al paisaje kárstico. Discutir y compartir por qué se seleccionaron esas preguntas y cómo se alinean con los objetivos.

Se espera que surjan preguntas inevitables relacionadas con los agentes internos y externos que dan forma al paisaje. En espacio pos-campo, y en otros momentos de clase, los estudiantes podrán familiarizarse con los agentes internos, mientras que la salida de campo estará enfocada especialmente en los agentes externos, con énfasis en el papel del agua.

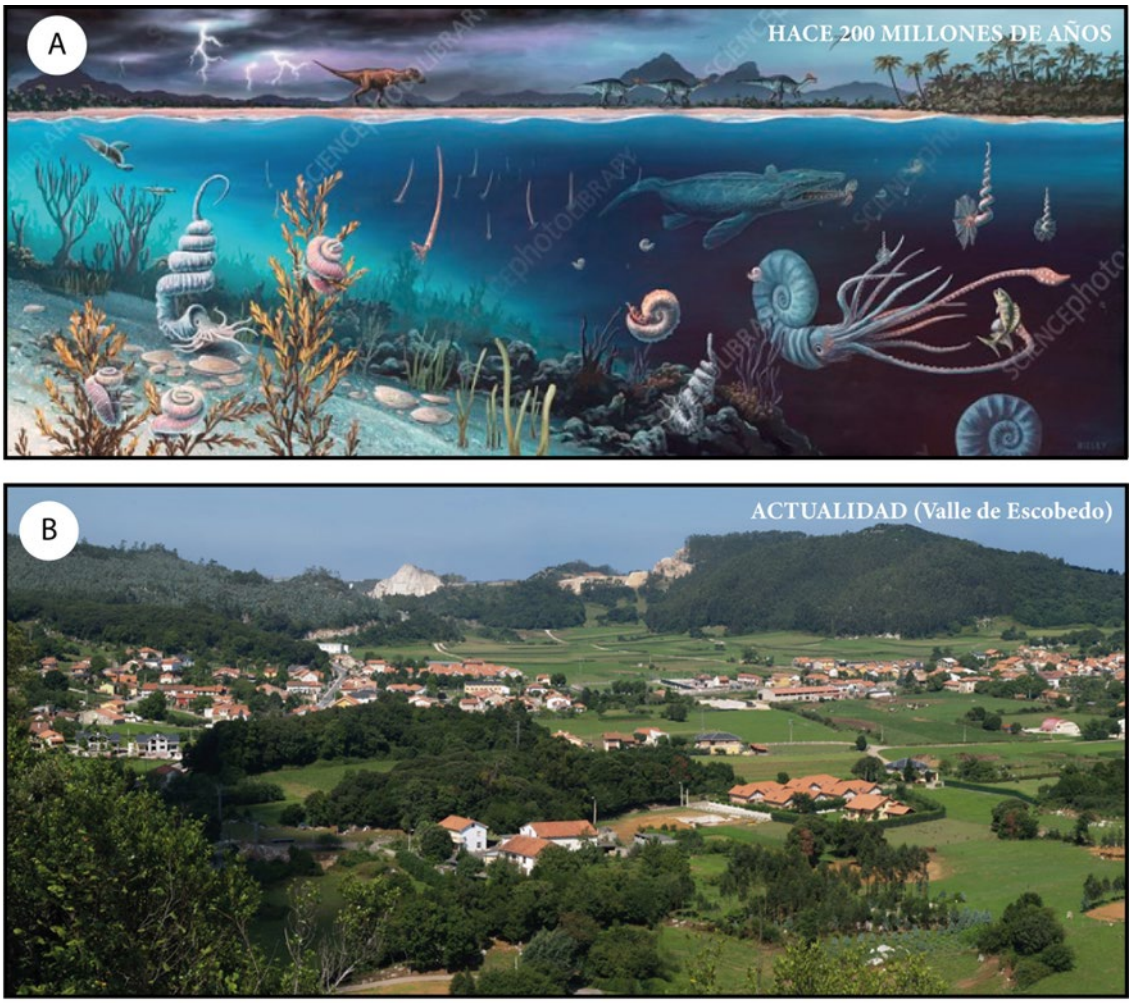


Figura 1. QFocus sugerido para actividad pre-campo.A) Representación artística de un océano durante el periodo Cretácico (Crédito: Richard Bizley en Science Photo Library - https://www.sciencephoto.com/media/631682/view/cretaceous-land-and-marine-life-artwork). B) Imagen del valle de Escobedo en el municipio de Camargo (Crédito: David Val en el Periódico de Yecla - https://elperiodicodeyecla.com/ascenso-camargo-escobedo-yeclano/).

Actividad en Campo:

Kárstico y dinámico: Un viaje de descubrimiento por el relieve de Camargo

En principio, se enfatizará a los estudiantes la importancia de mantener en mente sus tres preguntas clave durante toda la salida de campo y tomar notas en un cuaderno cada vez que reciban información relevante que responda o se relacione con sus preguntas. Se les recordará que cada grupo deberá elaborar un breve informe con las respuestas a sus preguntas planteadas, utilizando lo aprendido durante la excursión.

Además, se animará a los estudiantes a realizar un proyecto personal durante la salida, donde cada parada escribirá un comentario sobre lo que más les llamó la atención en ese sitio, lo que aprendieron o incluso algún sentimiento que les haya provocado el paisaje. También podrán acompañar sus comentarios con imágenes que capturen sus experiencias.

Para hacer la excursión más interactiva, se sugiere incluir un crucigrama que los estudiantes deberán llenar durante la salida, en el cual cada parada estará asociada con una palabra clave que los estudiantes deberán averiguar según las descripciones dadas en cada sitio. Esto les permitirá reforzar el aprendizaje de manera lúdica.

Los sitios a visitar están indicados en la Figura 2, en el orden en que serán explorados durante la salida de campo. El recorrido cuenta con aproximadamente 6.2 km.

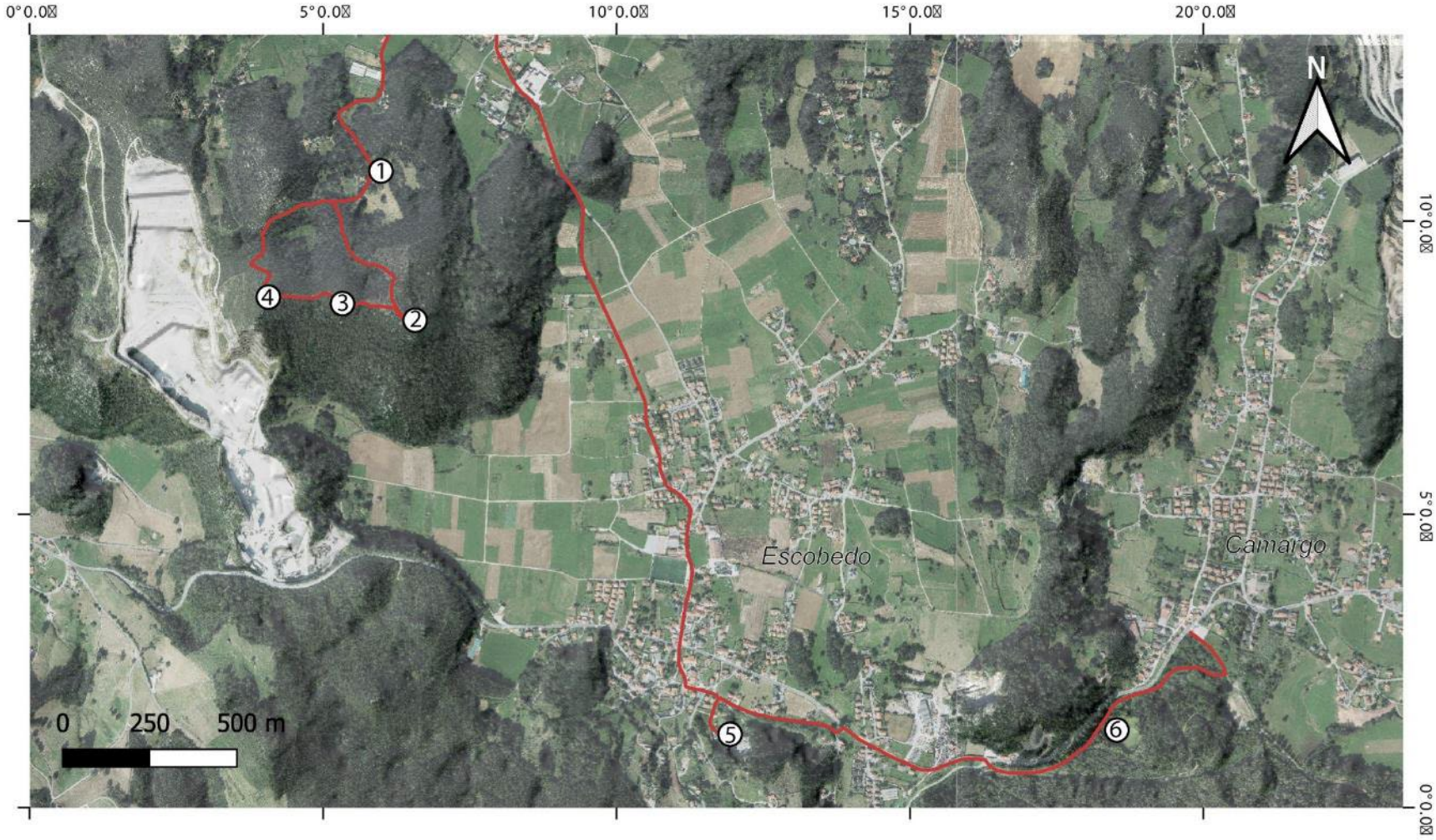


Figura 2. Mapa de la ruta a recorrer durante la salida de campo al paisaje karstico de Escobedo.

Parada 1:

- En esta parada, los estudiantes explorarán las dolinas presentes en el paisaje kárstico, observarán su forma y origen. Antes de explicar lo que están viendo, los estudiantes realizarán un dibujo o esquema para representar cómo creen que se formaron. Alternativa o adicionalmente, escribirán las características particulares que notan de esa estructura, que diferencian del resto del entorno.
- Luego, algunos de los estudiantes compartirán sus observaciones y posteriormente se dará una breve explicación. Es posible compara la dolina con un embudo para facilitar la comprensión.
- Es importante destacar que el agua ha sido el agente clave para crear esta estructura a lo largo del tiempo. Además, introduciremos el hecho de que la roca caliza, característica de todo el territorio de Camargo, juega un papel fundamental para posibilitar la formación de estructuras como las dolinas.

Parada 2:

- En esta parada, con una vista privilegiada al valle de Escobedo, se planteará una pregunta a los estudiantes relacionada con el conocimiento adquirido sobre el paisaje kárstico y la formación de la dolina. Se les preguntará cómo creen que se formó este valle considerando lo que han aprendido hasta ahora.
- Después de escuchar las ideas de los estudiantes, explicaremos una de las teorías que explican el origen del valle kárstico (también conocido como polje). Según esta teoría, el

valle se formó a lo largo del tiempo mediante la unión de grandes y varias dolinas, creando una inmensa depresión que se manifiesta como el valle que están observando en ese momento.

- Es importante destacar que la formación de un paisaje de tal magnitud requiere un proceso lento y gradual. El agua, como agente modelador en el paisaje kárstico, desempeña un papel fundamental en esta transformación. Si bien no se puede determinar con certeza el tiempo exacto que llevaría formar un valle de esta magnitud, se puede comprender que es un proceso que requiere un lapso significativo en términos geológicos.

Parada 3:

- En esta escombrera de roca caliza, se animará a los estudiantes a realizar su propio experimento para comprobar la reacción química entre la roca caliza y el jugo de limón. Además, se darán instrucciones para obtener una reacción química más visible. Aprovechar la oportunidad para explicar de manera breve cómo ocurre la disolución de la roca caliza y cómo el agua actúa como un agente de disolución.
- Aprovechando la oportunidad de estar en un lugar con una gran exposición de roca caliza, también se analizará el viento como un agente desgastante de las rocas, especialmente en un ambiente donde la vegetación es escasa. Se destacará el poder erosivo del viento y su influencia en la configuración del paisaje.
- Además, se mostrarán rocas calizas con restos fósiles, y de manera sencilla, se explicará cómo se forma la roca caliza y por qué se pueden encontrar fósiles en ella. Se animará a los estudiantes a explorar entre los escombros en busca de algún trozo de roca con contenido fósil.


Parada 4:

- Desde esta parada, se tendrá la oportunidad de analizar la huella antrópica en el paisaje y reflexionar sobre la gran capacidad que tiene el ser humano para modificar su entorno. Un ejemplo evidente de esta intervención se encuentra en el monte vecino, donde se puede observar la explotación de la roca caliza.
- Durante esta parada, se destacará los beneficios que los recursos geológicos brindan a la sociedad, como por ejemplo la obtención de materiales para la construcción (historia de la "Piedra de Escobedo"), entre otros usos importantes la vida cotidiana. Sin embargo, también se abordará el impacto que esta actividad puede tener en el entorno natural.
- La parada permitirá explorar y debatir acerca de la relación entre el ser humano y su entorno natural, tomando conciencia de la responsabilidad que tenemos como sociedad para preservar y proteger el paisaje y los recursos geológicos que tanto benefician nuestra vida, al tiempo que garantizamos un equilibrio con la naturaleza.

Parada 5:

- En esta cantera, se explorará la rehabilitación del entorno y se destacará la relación entre la vegetación y el relieve. Se observarán ejemplos de cómo algunas plantas, mediante sus

raíces, aprovechan los lugares con más heterogeneidades o acumulación de agua para penetrar en la roca y fijar el suelo, protegiendo así las montañas de la erosión.

- Desde el mirador de la cantera, también se puede apreciar la extensa llanura de Escobedo, y con esta vista, hacer reflexionar a los estudiantes sobre cómo la urbanización del suelo ha transformado drásticamente el paisaje.
- Se destacará que el suelo es un recurso no renovable, y que la llanura cuenta con un suelo especialmente fértil, lo cual está relacionado con la presencia de la característica roca caliza del lugar. Este suelo fértil es de vital importancia para la seguridad alimentaria, ya que es fundamental para el cultivo de alimentos. Esto permitirá relacionar los ODS (Objetivos de Desarrollo Sostenible) con la conservación y el uso adecuado de los recursos naturales, como el suelo.


Parada 6:

- Durante esta visita, los estudiantes tendrán la oportunidad de conocer el lago artificial conocido como "Pozón de la Ruperta" y descubrir la interesante historia detrás de su creación, la cual está estrechamente relacionada con la sobreexplotación de aguas subterráneas en el pasado y la actividad minera en la región.
- En esta parada, también se explicará de manera concisa qué es un acuífero y su relevancia en el ciclo hidrológico. Se destacará el papel fundamental que desempeñan las aguas subterráneas, ya que representan casi el 30 % de todas las reservas de agua dulce del planeta. De esta forma, se enfatizará la importancia de preservar y proteger estas valiosas fuentes de agua dulce.
- Los estudiantes podrán comprender cómo la explotación desmedida de los recursos hídricos en el pasado tuvo un impacto significativo en el entorno, lo que llevó a la creación de este lago artificial como una medida para mitigar los problemas derivados de la sobreexplotación.

- Además, al entender la importancia de los acuíferos y las aguas subterráneas como una reserva de agua dulce, los estudiantes adquirirán una mayor conciencia sobre la necesidad de adoptar prácticas sostenibles en el uso y gestión del recurso hídrico.

Actividad Pos-Campo:

Reflexión y síntesis del aprendizaje

1. Elaboración de un informe: Los grupos de estudiantes, con la guía del docente, elaborarán un breve escrito que responda las tres preguntas que seleccionaron en la actividad pre-campo, incluyendo el registro de sus observaciones durante la salida de campo.

2. Presentación de hallazgos: Cada grupo presentará sus respuestas a las preguntas clave que plantearon antes de la salida de campo.

3. Presentación y debate: Los estudiantes compartirán sus informes y experiencias con el resto de la clase, seguido de un debate para profundizar en el tema.