



The Ambitious Geological Park Initiative Is Currently in Progress In Nalut.

Osama Hlal^{1*}

¹Department of Geology, Faculty of Science, University of Tripoli, Tripoli, Libya.

*Corresponding author email: Osama.Hlal@gmail.com / O.Hlal@uot.edu.ly

Abstract

The ambitious geological park project currently being developed in the Nalut region highlights an impressive record of 130 million years of evolution, covering the Mesozoic era. It chronicles key events from the rise of dinosaurs to their eventual extinction at the close of the Cretaceous period, as well as the extinction of various terrestrial and marine species due to factors like oxygen depletion, climate change, geological shifts, and the retreat of the sea during the Jurassic period. This era was marked by heavy rainfall, the loss of dense coniferous forests, and a global rise in sea levels that submerged many land areas during the Cretaceous, resulting in the deposition of limestone over various sedimentary layers of different ages in Libya, and North Africa. The site holds significant geological historical value, serving as a foundation for studying the extensive Nubian continental sediments and their considerable economic importance.

Nalut boasts numerous geologically important sites, featuring unique formations and structures. Key locations include the Malha area, which is home to a fossilized forest and a variety of fish and dinosaur remains, as well as Wadi al-Mardawat, known for its dinosaur discovery sites (often called the dinosaur graveyard), the fossilized forest at Taqalalast, and dinosaur footprints in the Wazin area, along with the Azdun site.

1. Introduction

Global Geoparks are sites of significant geological heritage located in specific geographical regions. These areas are studied and evaluated by experts and are granted protection. They serve as important resources for education and sustainable development.

Geopark can be defined tentatively as a theme park, functioning of which contributes to conservation of unique geological features and their exploitation for the purposes of science, education, and tourism. Conceptualization and detailed



explanations of the idea of geoparks were given by Henriques and Brilha (2017), Reynard and Brilha (2018), and Herrera-Franco, Montalván-Burbano, Carrión-Mero, Jaya-Montalva, and Gurumendi-Noriega (2021), Azman, Halim, Liu, and Komoo (2011), Wang, Tian, and Wang (2015), Martínez-Frías, Mederos, and Lunar (2017), Du and Girault (2018), Gray (2019), Canesin, Brilha, and Díaz-Martínez (2020),

UNESCO Global Geoparks are clearly defined areas with an officially recognized administrative structure at the national level, which provides each geopark with legal status and identity. Their operations are governed by local and national legislation that must comply with regional and international standards regarding global geoparks.

The management and institutions responsible for UNESCO Global Geoparks oversee activities related to the care, preservation, and optimal utilization of these parks for the benefit of local communities, in collaboration with civil society organizations. These parks must implement a strategic plan that addresses the economic needs of local populations while protecting the natural landscapes they encompass.

UNESCO Global Geoparks encourage the sharing of advice and expertise among themselves. They should also foster collaborative projects with regional geopark networks, and UNESCO must continue to support the initiatives of the international geopark network.

The connection between UNESCO and the Global Geoparks :

The relationship between UNESCO and global geoparks is established by the Global Geoparks Network Advisory Board, which serves as a consultative body for the organization. This board is responsible for reviewing and making recommendations regarding UNESCO's decisions on new applications for UNESCO Global Geoparks and those in need of rehabilitation. Members of the board are selected based on their expertise, specifically requiring a minimum of five years of professional experience in fields such as geopark activities, geological heritage, sustainable development, tourism promotion, and environmental issues.

To ensure a broad geographical representation, six members are chosen from UNESCO's electoral groups. Additionally, the board includes representatives from regional networks, totaling ten members, with two representatives selected from each regional network of UNESCO Global Geoparks, each consisting of twenty



members. Moreover, each major organization that guides the scientific quality and practical applications of geoparks is allocated a seat on the board. The board is further supported by two members from the UNESCO secretariat.

The Director-General of UNESCO appoints all council members for a four-year term, which can be renewed for an additional term. The council meets annually in September to assess reports, carry out evaluations, create rehabilitation programs, and provide recommendations to the Director-General of UNESCO.

2. National Committees for Geoparks:

UNESCO member states that are actively engaged in the development of UNESCO Global Geoparks are encouraged to form a national committee for geoparks, which may also be known as a national group, working team, or national forum. This committee can comprise:

- A representative from the national commission for education, culture, and science
- A representative from the national geological organization (such as an industrial research center)
- A representative from the national environmental organization (like the national environmental authority)
- An expert from the cultural sector
- An expert from the tourism sector
- A representative from UNESCO (from the regional or national UNESCO office in the respective country).

3. The UNESCO International Conference on Global Geoparks

The UNESCO International Conference on Global Geoparks takes place every two years. To host the conference, applications must be submitted to UNESCO no later than three months after the most recent conference concludes. If a hosting application is accepted, the host country (or countries) will manage to fund the conference and provide the necessary facilities for its execution. This conference serves as a forum for discussing strategies and promoting the development of UNESCO Global Geoparks, as well as for establishing new mechanisms vital for the activities of the international geopark network, including policies, strategies, development, and funding.

4. Evaluation procedures:

Applications to join UNESCO's Global Geoparks initiatives are submitted by a scientific advisory team that independently manages the process, evaluating the significance of the applicant country's national geological heritage. The



International Union of Geological Sciences (IUGS) coordinates the assessment, ensuring that the application includes all necessary scientific data, including field evaluations of the proposed geological park, promptly. UNESCO has designated a group of qualified evaluators to assess applications from regions seeking to become UNESCO Global Geoparks. These evaluators must have expertise in geological research, development, geological heritage, sustainable development, tourism, and environmental issues, as these factors are vital to the application evaluation process.

5. A total of 177 geological park sites can be found in 46 different countries around the world.

UNESCO emphasizes the significant global importance of the "UNESCO Global Geoparks" designation in acknowledging geological heritage. This designation was unanimously approved by member states in 2015. The United Nations Educational, Scientific and Cultural Organization states that the sites within this network "feature exceptional geological diversity that contributes to biological and cultural diversity across various regions." Additionally, "these geoparks support local communities by striking a balance between preserving their unique geological heritage and promoting public awareness and sustainable development." With the recent addition of eight new designations, the global network of geoparks now covers approximately 370,662 km² worldwide, which is comparable to the size of Japan, as highlighted in the UNESCO statement.

6. Research Problem

Nalut is rich in natural, geological, and environmental features that make it one of the most appealing regions for geological tourism globally and a strong candidate for inclusion in the global geoparks network; however, it is currently not represented on the map (Fig. 1).

7. Research Objectives.

- I. Gaining insight into geological tourism and its main characteristics.
- II. Acquainting oneself with the idea of geological parks and the requirements for becoming a member of the Global Geoparks Network.
- III. Emphasizing the geological, natural, and archaeological assets of Nalut.
- IV. Analyzing the obstacles encountered by the promising Nalut Geopark and identifying the crucial components necessary for effective sustainable environmental marketing.

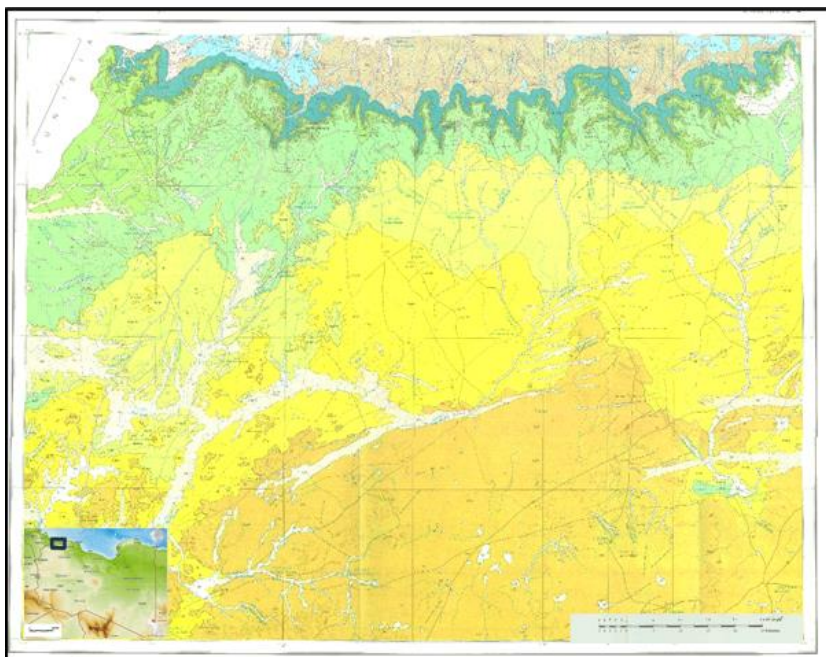


Fig. 1. A Geological Map of Nalut (indicated by a box).

8. The importance of the ambitious geological park initiative currently being developed in Nalut.

- Torabi et al. (2011) emphasize the crucial impact that geological parks have on the economic growth of the countries that host them. These parks attract geological tourists, leading to an influx of funds into the local economy. Furthermore, geoparks aid in revitalizing local industries and crafts, while also promoting local products. They play a vital role in preserving geological heritage for both present and future generations, encouraging multicultural interactions, sustaining geological and cultural diversity, and advancing scientific research (Unesco, 2015).

- The process for establishing a global geopark begins with an initial assessment for accreditation conducted by an independent advisory team that evaluates both theoretical aspects and field missions. Subsequently, the park undergoes re-evaluation every four years to ensure it continues to meet the necessary criteria for maintaining its status. A report is submitted to UNESCO, and if the park does not comply with the global network standards, it receives a set of recommendations for

improvement. If the park fails to meet the criteria within two years, it will be removed from the membership list and forfeit all associated privileges within the geopark network (Nagla, 2017; Unesco.org).

9. The geomorphology, culture, and historical background of the Nafusa Mountains.

Mount Nafusa is a significant geomorphological feature situated in northwestern Libya, known for its varied topography and well-preserved formations that offer insights into its geomorphological history (Fig. 2) . Its rise above sea level is likely linked to the lower Eocene epoch, following a geomorphological evolution that began in the early Eocene. During this time, the western section ascended without deformation, forming a broad, convex fold near Al-Khums. To the north, it is bordered by a fragmented plateau with varying elevations that curve in an arc for approximately 320 kilometers. The eastern part of the mountain has a prominent edge that begins at Gharian's longitude of 13 degrees east and extends to the mountain's easternmost point. In the western section, a distinct edge is visible for about 9 kilometers, beyond which significant erosion has occurred, resulting in a landscape of low hills and valleys.



Fig. 2. Escarpment of Jabal Nafaush at Nalut area.



The elevation of the mountain's edge decreases from the eastern sector to the Yafran line, ranging from 600 meters to 200 meters. Furthermore, the ruggedness of the terrain diminishes from 300 meters to less than a third, and this area contains some basic volcanic rocks located in the southwestern part, dating back to the late Tertiary period. It is essential to highlight that the most notable characteristic of the riverbeds in this area is their remarkable straightness, especially when compared to other directions, particularly towards the east. While there have been several perspectives on the geomorphological evolution of the mountain edge, Lipparini offers the most thorough explanation, which can be summarized in the following points.

Erosional processes before the Miocene epoch were instrumental in shaping the Jafara Plain and forming a northern mountainous edge, which later receded southward from the latitude of Aziziyah due to tectonic activity along the Aziziyah Fault. This resulted in the northern part of the Jafara Plain sinking, enabling the sea to move southward until it reached the fault's edge. Consequently, marine deposits built up in the subsiding area of the plain during the Miocene and later periods, while the mountainous edge continued its retreat southward until it reached its present position.

Jabal Nefusa creates a natural crescent that surrounds the Jafara plain and its coastal cities to the southwest, blending seamlessly with the slopes of the Red Hamada. Its northern edge overlooks the Jafara lowland, which is crisscrossed by deep, historically significant dry riverbeds. These riverbeds are primarily composed of Cretaceous rock formations (Figs. 3, 4), which geologists trace back to the Middle Jurassic period, and the chalky deposits from the late second geological era. At that time, the area was characterized by rivers and swamps interspersed with dense forests. The mountain's formation and prominence occurred during the lower Eocene epoch, with its edges defined by steep rock walls that rise between 650 and 900 meters. Many of these walls have caves and caverns that date back to the Quaternary period (Pleistocene). The valley floors feature cliffs that host numerous springs, many of which still flow today. These springs were vital for early human settlements, enabling communities to develop around them and fostering both pastoral and sedentary lifestyles as human civilization progressed. The streams from these valleys eventually converge in basins filled with alluvial clay and gravel deposits, carried by the streams flowing from the mountain peaks once provided vital nourishment to the land during a time when they were more plentiful than they are now.

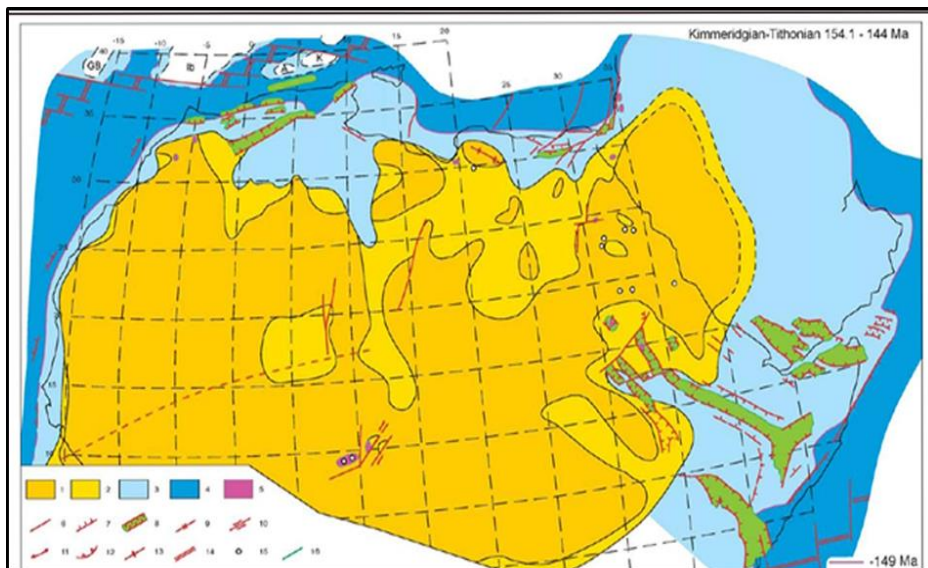


Fig. 3. A geological map depicting the Cretaceous period in Libya and its continuation into the Jabal Nefusa area.

Fig 4. An illustration of different ways of life during the Cretaceous period (The establishment of the Libyan Museum of Dinosaurs and Natural History) .

This natural resource formed the basis for the sustenance of the local community and offered grazing areas for their livestock and sheep. Spanning an extensive area of 1,106,352,000 square kilometers, the region show cases a variety of landscapes, including mountains, plateaus, valleys, plains, and sandy or rocky deserts. It is abundant in architectural and cultural heritage, with diverse locations and populations that together contribute significantly to the nation's cultural identity. Each mountain peak, hill, plateau, slope, valley floor, cave, and cavern holds natural and human remnants narrating stories and histories, reflecting the relationship and interactions between people and their material, natural, and animal resources over time. Today, individuals take pride in this Libyan heritage, drawing inspiration from the natural and human legacies of their ancestors, which allows them to delve into the history, culture, and connections of their forebears through the walls, rooms, caves, and agricultural terraces that preserve their past.

This geographical region is rich in thousands of archaeological and natural sites, dating back to the age of dinosaurs. It features dinosaur discovery sites, fossilized forests in the Nalut area (Fig. 5), and other mountainous locations that contain remnants of dinosaur bones (Figs. 6,7), crocodiles, turtles, and sharks.



Fig. 5. Investigative efforts in the Petrified Forest located near the city of Nalut



Fig. 6. The numerous exploratory excursions to the location in Nalut where dinosaur



Fig. 7. Fossilized dinosaur bones have been found in the vicinity of the city of Nalut.

The timeline encompasses everything from prehistoric sites to historical periods, highlighted by the emergence of writing—whether pictorial or inscriptive—alongside the ancient Libyan civilization, Phoenician settlements, and Roman and Islamic influences, extending into contemporary times. Various religions have thrived throughout these eras, similar to cultures worldwide, including paganism, Judaism, Christianity, and Islam. Consequently, one can find temples, churches, and mosques in a variety of architectural styles. Unfortunately, this rich heritage has faced neglect and destruction in recent decades, affected by natural elements, human actions, and the oversight of relevant authorities, whether intentional or unintentional. This legacy reflects the history of a select group of people who have inhabited Libya from prehistoric times to the present day. Some of these sites have been classified and preliminarily identified as follows:

- Overview of Prehistoric Sites:

1. Over fifteen sites have been identified, encompassing a total of 50 caves and caverns (Fig. 8).
2. There are around 55 temporary pastoral settlements (Fig. 9).
3. Extensive burial grounds for pastoral communities are located on the mountain slopes and the Hammada Hammra.
4. A variety of stone tools and hunting implements (Fig. 10), with more than 150 items recorded, have been found on the slopes of the Hammada Hammra and the foothills of Mount Nalut, in collaboration with international partners.
5. Fire pits are commonly found across the vast areas of the red plateau and the base of the mountain.
6. Engraved wall art has been discovered at eight sites (Fig.11), which include: 1. Atef bin Dalalah 2. Shaoua 3. Bir Nasira 4. Wadi Al-Khayl 5. Wadi Al-Akhira 6. South of Mizda 7. Al-Kaliba 8. The city of Oru (Al-Awina).
7. Sites for flint knapping and stone tool production are distributed throughout the mountain range. –



Fig. 8. Stalagmites and stalactites discovered in the cave at Jabal Nafuash.



The Non-Local Archaeological Sites

1. Sites of settlement and burial for the Phoenician Libyans.
2. Locations and cities bearing Phoenician names, such as Uro, Sefit, Arnon, and Akka.
3. Roman Libyan sites, including temples, tombs, fortified farms, Roman roads, water cisterns, olive presses, grape presses, and various unidentified structures.
4. A total of ten Christian churches.
5. Churches that were later converted into mosques, including the Church of the Virgin, totaling twelve.
6. Synagogues, temples, and Jewish burial sites.



Fig. 10. The Nalut region is renowned for several traditional crafts.



Fig. 11. Several murals have been uncovered in the Nalut region.

Local architecture.

1. Historical and archaeological villages and towns (230) villages (Fig. 12).
2. Mosques and religious schools (246) mosques and Quranic education centers (Fig. 13).
3. Storage palaces of various sizes (179) palaces.
4. Fortresses and watchtowers (80) of different sizes and shapes for guarding and surveillance.
5. Olive oil presses in each village (Fig. 14), with more than one press, almost every family has its dedicated press.
6. Gypsum kilns, the primary material in local architecture, are numerous along the mountain range (Fig. 15).
7. Pottery kilns, with a documented count of 15 kilns so far, through the efforts of the local heritage and tourism committee in Jebel Nafusa.
8. Water facilities including cisterns, dams, wells (locally known as "saniya"), and flowing springs.
9. Mountainous and desert pathways and trails.
10. Religious shrines and tombs.

11. Service locations such as shops and gathering places, especially for wedding celebrations and religious events like Ashura.

12. Centers for traditional crafts including wool, hair (Fig. 16), camel hair, palm fronds, as well as woodworking, metalworking, textile production, and leather crafting.



F. 12. The historic Nalut palace taken from different perspectives.



Fig. 13. The Qasr Mosque is situated in the city of Nalut.



Fig. 14. An ancient olive press found in the city of Nalut.

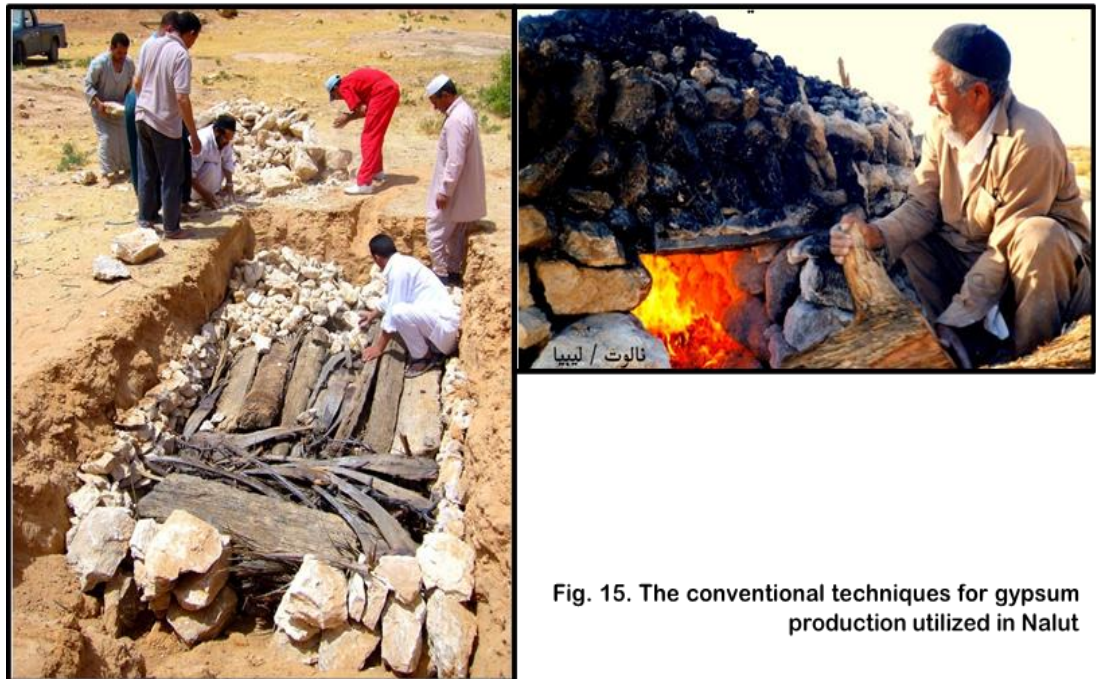


Fig. 15. The conventional techniques for gypsum production utilized in Nalut

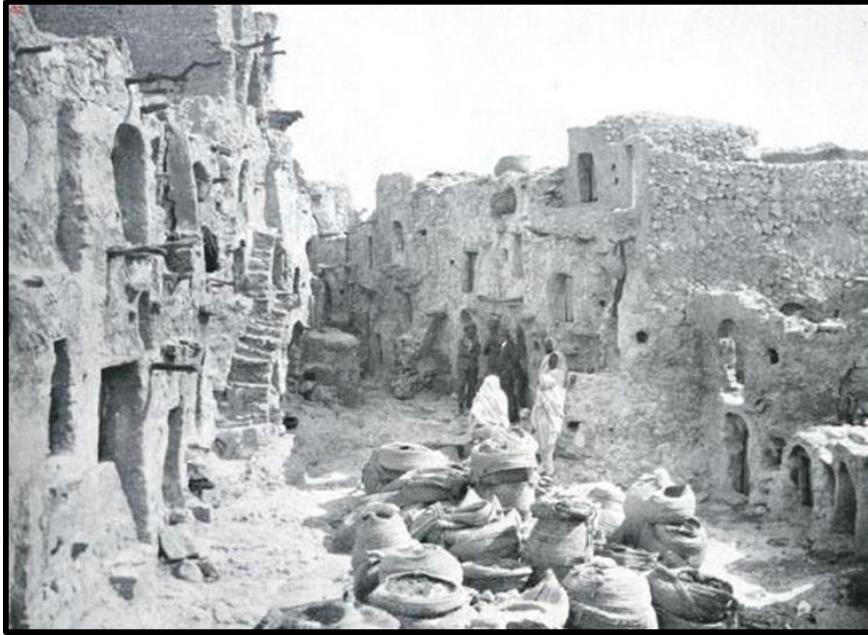


Fig. 16. Gathering wool in specified locations in anticipation of its storage and processing.

Recommendations

Many other factors cannot be discussed at this time, which play a crucial role in the archaeological, cultural, and natural attributes of Mount Nefusa. These elements have suffered neglect for many years, resulting in significant damage and a loss of memory that has obscured the history of past civilizations in this area. As you know, this extensive array of natural history and cultural heritage—encompassing both architectural styles and distinctive folk traditions—has reached a critical condition. It necessitates urgent action to safeguard and maintain it against natural threats and the detrimental activities of individuals, including excavation, destruction, and demolition, as well as exploitation for profit or urban development. Furthermore, the preservation of folk heritage faces similar threats from commercialization and potential loss.

Considering the reports from archaeological observers about the regular civil field visits, along with the efforts made by local councils in the Jebel Nafusa region to create a civil entity dedicated to documenting, promoting, and preserving these sites, it is crucial for us, as contemporary observers, to recognize our current resource limitations that impede our ability to meet our responsibilities. This is a national



obligation toward our heritage, and all of us need to engage in organized and systematic work utilizing scientific and practical methods.

Therefore, we urgently seek your support in providing all requirements and the attached disclosures, whether for monitoring purposes or the relevant offices. We strongly recommend and stress the importance of taking the following actions.

1. Assist the monitoring body and its associated offices to ensure the successful implementation of their assigned responsibilities.
2. Incorporate funding for the restoration and maintenance of archaeological and historical sites under the monitoring authority into the institution's budget, including protective measures like fencing around specific sites. Collaborate with relevant local and international organizations to support these initiatives in consultation with the monitoring authority.
3. It is crucial to establish centers dedicated to the preservation of movable artifacts and intangible cultural heritage, such as storage facilities and museums, to reduce the risk of loss and to present these items in a scholarly and respectful manner, thereby emphasizing the region's culture, heritage, and civilization. Additionally, efforts should be made to return items currently held in main storage or their replicas to their original locations within the region's museums.
4. It is necessary to document, number, register, and create a database for these sites, as well as to define their protected areas and install legal signage that indicates their protection under heritage law.
5. Urgent action is required to collect movable artifacts currently situated in unprotected areas.
6. Prioritizing the appointment of observers for archaeological sites, who are interested in such positions across all municipalities, should be based on the historical and archaeological importance of the sites.
7. Collaboration with security agencies, including municipal security directorates, tourism police, and land and air border authorities, is crucial to prevent illegal excavations, theft, and trafficking of artifacts.
8. Training programs should be developed for employees to potentially enable them to attain the status of judicial police officers, if possible.
9. It is essential to establish protective zones for certain sites that are at risk of demolition, especially those located within urban planning projects.
10. Engineering surveys should be carried out (Fig. 18), with the potential to prepare assessments for buildings that are damaged and at risk of collapse.
11. The initiative seeks to list specific distinctive and unique buildings on the World Heritage List.



12. Training programs will be developed for employees focused on the registration of archaeological sites and the creation of a database for them.
13. Brochures and posters will be designed to highlight the region's history and heritage.
14. The project to create a database for Jabal Nefusa, which began in 2014 at the Nalut Antiquities Office, will be finalized.
15. Collaboration with municipalities will be pursued to investigate the potential for establishing storage facilities for movable antiquities, as well as buildings for museums or land allocation for these purposes.
16. In light of the numerous damaged and historical buildings, many of which have completely collapsed due to natural causes and neglect by the public, along with the absence of restoration or maintenance by the relevant authorities over the past decades, it is crucial to set up a dedicated kiln for producing local gypsum. This will aid restoration and maintenance efforts in the offices, as local gypsum serves as the primary binding material for any restoration work.

Conclusion

The ambitious geological park project in the Nalut region is a remarkable initiative that seeks to illuminate an impressive timeline of 130 million years of evolution, specifically focusing on the Mesozoic era. This era, often referred to as the "Age of Reptiles," is characterized by significant geological and biological transformations that shaped the Earth as we know it today. The project aims to chronicle key events that occurred during this extensive period, from the rise of dinosaurs, which dominated the planet for millions of years, to their eventual extinction at the close of the Cretaceous period, approximately 66 million years ago.

In addition to the extinction of dinosaurs, the project delves into the broader context of the extinction of various terrestrial and marine species that occurred during this time. These extinctions were influenced by a multitude of factors, including oxygen depletion in the oceans, dramatic climate change, significant geological shifts, and the retreat of the sea during the Jurassic period. The Jurassic era itself was marked by heavy rainfall, which contributed to the lush, verdant landscapes of the time, as well as a decline in dense coniferous forests that had previously thrived. Furthermore, the Cretaceous period saw a global rise in sea levels, which submerged vast land areas, leading to the formation of extensive limestone deposits across various sedimentary layers of different ages found in Libya and North Africa.



The Nalut region, with its rich geological history, holds significant importance for researchers and scientists. It serves as a foundational site for studying the extensive Nubian continental sediments, which not only provide insights into the Earth's past but also possess considerable economic potential. The geological park is designed to be an educational resource, showcasing the intricate relationship between geological processes and biological evolution.

Within Nalut, numerous geologically important locations feature unique formations and structures that tell the story of the Earth's history. Notable sites include the Malha area, which is home to a fossilized forest that offers a glimpse into the ancient ecosystems of the Mesozoic era. This area also contains various fish and dinosaur remains, providing invaluable evidence of the diverse life forms that once inhabited the region. Another significant site is Wadi al-Mardawat, renowned for its dinosaur discovery sites, often referred to as the "dinosaur graveyard." This location has yielded numerous fossils, contributing to our understanding of dinosaur diversity and behavior.

In addition to previously mentioned points of interest, several significant attractions draw visitors and researchers. The fossilized forest at Taqalalast offers insights into ancient ecosystems and flora, making it a valuable site for paleobotanists and history enthusiasts.

Another notable attraction is the collection of dinosaur tracks in the Wazin region, which provides a tangible link to the prehistoric past and insights into dinosaur behavior and environmental conditions.

Additionally, the Azdun archaeological site is rich in artifacts and structures that illuminate the cultural and historical development of the region, attracting the interest of archaeologists and historians. Together, these sites enhance the area's cultural and scientific value, deepening our understanding of Earth's history and the evolution of life.

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A geological map depicting the Cretaceous period in Libya and its continuation into the **Jabal Nefusa area**

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