

# The Middle Atlas Domain of Morocco: Geoheritage Conservation Allowing Development in a Sustainable Manner

Souhail Mounir<sup>1,✉</sup>, Naoufal Saoud<sup>1</sup>, Kaoutar Mounir<sup>2</sup>, Jaouad Choukrad<sup>1</sup>, Abir Berbeche<sup>3</sup>, Mohamed Charroud<sup>1</sup>

<sup>1</sup> Faculty of Sciences and Technologies Fez (FSTF), Fez, Morocco

<sup>2</sup> Faculty of Science Dhar El Mahraz Fez (FSDM), Fez, Morocco

<sup>3</sup> National School of Applied Sciences Fez (ENSAF), Fez, Morocco

✉ [souhail022@gmail.com](mailto:souhail022@gmail.com)

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## 1. Introduction

Many natural sites in Morocco are geologically rich, especially in the Atlasic area. The potential of these geosites with their geologically diverse and complex features has been recognized by geologists worldwide. Yet, studies in geotourism and the sustainable development of these sites are generally lacking. Sumanapala and Wolf (2020), who reviewed the field of geotourism, found that although geotourism clearly constitutes an emerging sub-sector of nature-based tourism with great potential, only 26 studies have been published in this field in peer reviewed journals

to date. A lack of knowledge on how to assess the potential of geotourism sites has impeded their development as opportunities are not fully recognized. Assessments of the strength and weaknesses, along with opportunities and threats of geosites were recommended (Mounir, 2020).

Here we contribute to filling this gap by discussing the Middle Atlas in Morocco as a potential geotourism site. We evaluate the socio-economic, cultural and environmental conditions as they provide opportunities for development, and discuss the threats that impede such a development.

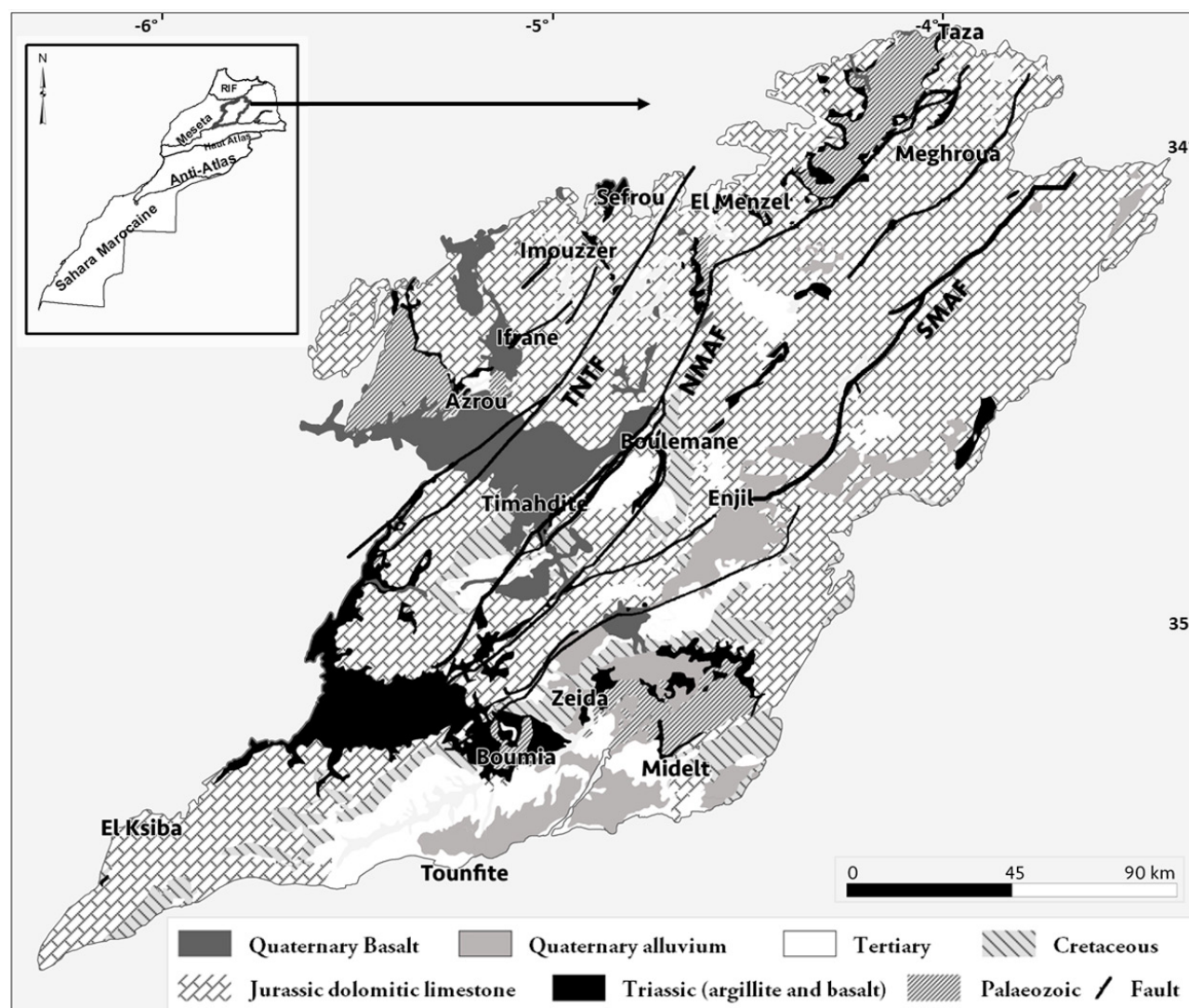


Figure 1: Geological Map of the Middle Atlas (after Mounir, 2020)

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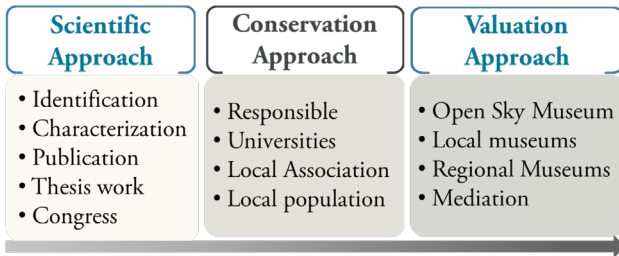


Figure 2: The main approaches, methods and interventions in the heritage industry process.

We highlight how the varied geomorphological and related elements of this geographic area showcase the geologically complex evolution of the Middle Atlas during the Meso-Cenozoic and the Quaternary. The rich portray of geological evolution lends itself to marketing and promotion of this site for geotourism.

## 2. Location and setting

The Middle Atlas (study area) is a part of the Atlasic domain. It is limited in the North by the South-Rifain corridor, in the East by the valley of the Middle Moulouya, in the South by the High Atlas of Beni Mellal,

and in the West by the central land (Western Meseta).

The Middle Atlas is essentially represented by anticlinal rifts intruded by gabbroic formations, and with separate large synclinal basins that translate a complex geological history during the Meso-Cenozoic and the Quaternary (Termier, 1936; Choubert and Faure-Muret, 1962; Charroud, 1990; Michard et al., 2008, Hinaje et al., 2015, Mounir et al., 2019).

The mountainous region is formed by a juxtaposition of two major structural domains. The Tabular Middle Atlas (Middle Atlasic causse) formed essentially by the carbonate formations of the Lias in the form by layered plateaus. The North Middle Atlasic fault (NMAF) separates the tabular domain from the folded Middle Atlas. The latter is marked by a series of folds and faults forming ripples separated by synclines with marine and continental Dogger formations (Figure 1).

## 3. Geo-heritage process

The heritage process is subject to several stages of characterization, preservation, reclamation and geo-



Figure 3: Examples of geological sites of special interest in the Middle Atlas. a-b. The Middle Atlas Heritage Interpretation Centre. c. Guigou meander (Taferdoust Kasbah). d. The Sources Oum er-Rbia Waterfall. e. Aguelmam Azigza National Park. f. The bathonian Theropod Trackways of the Central Middle Atlas. g. Karst reliefs and landforms. h. Azurite and malachite. i-j. The Plio-Quaternary volcanism of the Middle Atlas.

logically remarkable trail display. It reflects the emergence of a specific mode of territorial development and ensures a holistic approach to geoconservation (Mounir et al., n. d.).

The main purpose of this work is to present a general perspective on geological heritage, focusing mainly on concepts, terminology and methods of identification and evaluation, to understand and give a general overview of the spatial and temporal evolution of the geological history of the Middle Atlas, thus bringing new scientific and socio-cultural approaches to the region (Figure 2).

#### 4. The geological heritage of the Middle Atlas and its opportunities and strengths as a geotourism area

The Middle Atlas is a well-known outcrop set because of its stratigraphic relevance, which reflects the geodynamic history of the region. The diversity of these outcrops justifies the implementation of several strategies aimed at prioritizing geosites as a scientific place, educational, aesthetic and cultural interest. For this purpose, a systematic identification, characterization and evaluation of the geosites was carried out, taking into consideration the assessed interest, the rarity and the exceptional conservation status that the Middle Atlasic domain represents.

The geological heritage must be appreciated by the community; therefore the engagement with a large section of the society, through geotourism, may be an effective way to expand the importance of geological heritage as a valued part of the natural world (Sharples, 2002; Crofts and Gordon, 2015).

Consequently, after an analysis of the relationships between geological heritage and geotourism, Figure 3 illustrates several examples of the Middle Atlasic geoheritage in different geological contexts.

#### 5. The threats and weaknesses of the Middle Atlas as a geotourism area

Geosciences are still poorly displayed in Morocco, or not at all concerned by administrative acts. The speech is strongly aimed to MEM ministries by geoscience scientists and researchers during the last national and international meetings.

However, Morocco still has no law for the protection of its geological heritage, especially its internationally important fossil sites of Paleo-Mesozoic age, which are very vulnerable and at risk of disappearing due to their over-exploitation as ornamental rocks and fossil sites (Mounir, 2020).

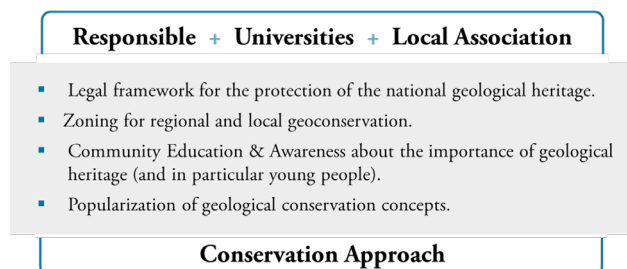


Figure 4: The key elements to ensure the protection, preservation and transmission of the natural wealth and heritage to future generations.

#### 6. Concluding remarks about the future of the Middle Atlas as geotourism region

A positive development was noted recently in the creation of the 'Geology Direction' framework and the integration of a geological heritage service and museums in a national road framework for the development of geological and geothematic infrastructure for the period 2015–2025 (MEMEE, 2015; Mounir, 2020).

An exceptional area was identified as a project for a future geopark in the Middle Atlas of international interest under the premises of ensuring the protection, preservation and transmission of geoheritage wealth to future generations. Cooperation with international organizations, scientific institutions, and a non-governmental organization will significantly strengthen efforts in the field of conservation and the promotion of the geological heritage in Morocco (Figure 4).

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