

# **Images of Moroccan Geological Heritage in Life and Earth Sciences Textbooks of Second Year College from 2004 to 2017: Case of the Volcanic Chain of the Middle Atlas**

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## **Authors' contributions**

*This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

The textbooks of Life and Earth Sciences (LES) are tools of learning and essential vectors of the geological heritage or "geosites". Based on this observation, we analyzed the content of two textbooks of the LES of the second year of the secondary school cycle, operative in Morocco (El Moufid and El Massar) from 2004 to 2017 about the geological heritage of the national territory relating to the volcano concept, more precisely, the volcanic chain of the Middle Atlas. This comparative analysis allowed us to determine whether there was an evolution of the content of this heritage through these years and the usefulness of the presence of this volcanic geological heritage

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in textbooks. For this comparative analysis, we used as an investigation tool an analysis grid. Our study revealed that there are indeed deep gaps in this concept. The conclusion, therefore, concerns the need to improve the contents of these two manuals, which have not changed over the years. Therefore, a major effort must be made to give a place to this volcanic geological heritage as part of the teaching of the LES and environmental education and heritage of learners.

*Keywords: Textbooks; life and earth sciences; geological heritage; geosite; volcanoes; middle atlas.*

## 1. INTRODUCTION

The sites of geological interest or "geosites" were the fruit of initiative of the association Natural Reserves of France (RNF) since (1985), sometimes also called "geoheritage". This concept is now recognized internationally according to De Wever [1]. The geoheritage concerns sites that encompass all geological objects and phenomena of all sizes, from macroscopic to microscopic (from landscape to mineral) whose remarkable interest in the memory of the Earth. Benefiting from a geological substratum particularly rich in geological phenomena (magmatism including volcanism and plutonism, metamorphic, Karstic, ... etc) in fossiliferous, mineral resources, etc., which mark a long geological history ranging from Precambrian until the current days [2,3,4,5,6]. Moroccan geosites of high scientific, educational, cultural, and socio-economic value ..., through the Earth sciences, can possibly constitute rich and diversified supports in the teaching and the learning of these Sciences any cycle of teaching and to further the interest of learners in local and national geology. They are also, an educational resource for citizenship that allows the promotion and awareness of the protection of these geosites. Among the sources that can shed a specific lighting on these Moroccan geosites we can mention: textbooks, advertising flyers, theses and scientific articles produced by researchers and websites that open new ways to access these geosites. Despite this, the diversity of learning materials in schools; the textbook remains widespread and effective [7]. It is widely used and favored by teachers [8,9]; Johnsen, 1993; [10,11]. The textbook is a central element in pedagogical practice and is recognized as one of the most effective factors for improving the quality of teaching, especially in states where the education system lacks resources [12], and it's a bearer of knowledge directed to students. Numerous studies have shown that textbooks are a major resource for teaching and, as such, play a vital role in the professional development of teachers [13,14]. Researchers have shown that textbooks also

have an important influence on student learning Garner, 1992, [15,16,17] and that the textbook is of paramount importance for the development of culture and educational success. textbooks in general and those of the SVT in Morocco are developed in accordance with the official guidelines prescribed by the curriculum [18]. In other countries, Morocco has integrated Environmental Education into primary and secondary education programs (Agorram et al. 2009). The new reform of the education and training system operated in Morocco in 1999 emphasized the introduction of Environmental Education in the scientific and literary curriculum at many levels from primary to secondary education [18].

In this study we will limit ourselves to the contents and objectives related to the concept of volcano taught in the second year of the secondary school cycle, more precisely the extinct volcanoes of the Middle Atlas conveyed by the textbooks of this cycle of education. It was based on a number of observations, first of all, the results we obtained from numerous surveys of students, teachers and future teachers of the SVT to identify conceptions about the existence of extinct volcanoes. in Morocco among others those of the volcanic chain of the Middle Atlas "volcanic geosites" [19,20,21]. The results obtained assert that the majority of respondents are unaware of the existence of these volcanoes simply ignored; hence the idea of seeking to highlight certain causes. Secondly, there is a large body of research claiming that textbooks are a preferred medium for teachers ([8,9, Johnson, 1993). Moreover, the analysis of textbooks in Morocco is a field of study quite exploited in biology [22,23,24,25,26,27]. Thirdly, we mention the delay of the didactic transposition (DDT) concerning the volcanic chain of the Middle Atlas which is long.

Finally, we add that the teaching of these Middle Atlas volcanoes will have a high interest in the Earth Sciences and positively influence the engagement of learners in the activities and the development of a local geological culture. and/or

national desired. Through this study, several questions are needed: 1) What place occupies the volcanic chain of the Moroccan Middle Atlas in these manuals of LES and how it is presented? 2) Is there an evolution in the content of this channel in textbooks published from 2004 to 2017? 3) What is the content of this volcanic chain in the context of the geological heritage that characterizes the Middle Atlas in particular and Morocco in general? 4) What impact could the lack of textbook heritage have on the school culture and general culture?

To answer these questions and consolidate the analysis of the two textbooks we have set ourselves the following objectives:

- Make a comparative analysis of the two Moroccan textbooks concerning the content of the geosite concept related to the Middle Atlas volcanoes contained in these textbooks.
- See if the content of a recently edited manual differs from the one published in 2004.
- Identify textbook authors' conceptions of the geosite concept for Middle Atlas volcanoes.
- Propose some ways that can improve the content of LES textbooks in order to promote and raise awareness of this geological heritage in order to obtain recognized and quantifiable learning outcomes, particularly with regard to these volcanoes.

## 2. METHODOLOGY

### 2.1 Corpus of Study

This study focuses on two Moroccan textbooks of LES in Arabic dedicated to the second year of secondary school, the only published since 2004:

- Al Moufid in LES (Dar Attaqafa manual Publishing House).
- Al Massar in LES (Nadia Publishing House).

### 2.2 Investigation's Tool

The methodology consists to analyze these textbooks content using an analysis grid that we have constructed in order to gather important information from these manuals (Annex I). We adopted the contrastive method, which is based on the comparison of several textbooks, in order to identify their structural differences and their

similarities concerning a given theme. Indeed, we used one of the typologies proposed by Bernard et al. [30] that compares several current textbooks dealing with the same content, in the same country whose objective is to detect the different images of the Middle Atlas volcanoes (photos, diagrams, map ...) and their possible interpretations appropriate to the contents of scientific and educational dimension according to said textbooks.

## 3. RESULTS AND DISCUSSION

The analysis of the two manuals (Table 1), showed that the content of the volcano concept taught in the context of internal geodynamics has not changed for 13 years: The content of a manual recently published in 2017 differs. This is indeed an important concept in the second year of secondary school, which poses difficulties that have been raised by many types of research in didactics of geology [31,19,20,21]. In addition, none of the two textbooks evoked in the construction of the concept of volcanic heritage of the Middle Atlas which is yet a veritable volcanological open-air laboratory of more than a hundred volcanoes of varying shape and eruptive fashion. This may be due to the fact that there is a lack of articulation between textbook designers and decision-makers and the results of research carried out by university geologists on the Middle Atlas volcanoes, which has nevertheless made notable progress (Martin, 1981; Moukadiri, 1983; Harmand and Cantagrel, 1984; Harmand and Moukadiri, 1986; Rachidi, 1995; Morel and Bellon, 1996; El Azzab and Wartiti, 1998; Missenard, 1998; El Azzouzi, 1999; EL Azzouzi and al. [32]; Charrière and al. 2011 ; El Amrani and al. 2014; El Wartiti and al., 2016; Sadkaoui, 2016 ...).

### 3.1 Textbook Al Moufid in LES from 2004 to 2017

In this textbook, we found no trace of images that refers to the extinct volcanoes of Morocco in general (Fig. 1, Annex I) or the volcanic chain of the Moroccan Middle Atlas in particular (Fig. 2, Annex II) in the chapter devoted to volcanoes and their relation to plate tectonics.

### 3.2 Textbook Al Massar from 2004 to 2017

Also in this textbook, we did not find any images in favor of the extinct volcanoes of Morocco in general nor of the volcanic chain of the Middle Atlas as they are shown in Figs. 1 and 2 (Annex

l) in the chapter devoted to volcanoes and their relationship with plate tectonics. However, in this textbook we find that:

- As part of the knowledge supplement related to the concept of volcano (p.35), it engages students and teachers in research and development activities based on research and documentation about extinct Moroccan volcanoes. As a result, the target population will participate in the construction of their own knowledge of these volcanoes and profit from their curiosity and satisfy it. Something that is not easy for the students of this cycle who study the LES in Arabic and the results of the researches in the university are in French or in English.

- In the context of another chapter that of formation of magmatic rocks, separated from that

of volcanoes by nine (9) pages devoted to the chapter of tectonic deformations and their relation to plate tectonics, this textbook of Al Massar touches shyly some volcanoes Middle Atlas whose iconographic content is presented in (Table 1). Indeed, three images are used to illustrate this volcanic chain.

The first image in this textbook, entitled panoramic view showing basaltic outcrops between Azrou and Timehdite (Fig. 1). For lack of a legend, the figure is not precise with respect to its content, it is up to the student to guess the basaltic outcrops. We note, on the one hand, that the origin of these basalts has not been specified and on the other hand, the volcano has not been reported, although it is an essential phenomenon to understand the presence of basalts in this portion of land.



Fig. 1. Panoramic view of basaltic outcrops between Azrou and Timehdite (p 48 in textbook)

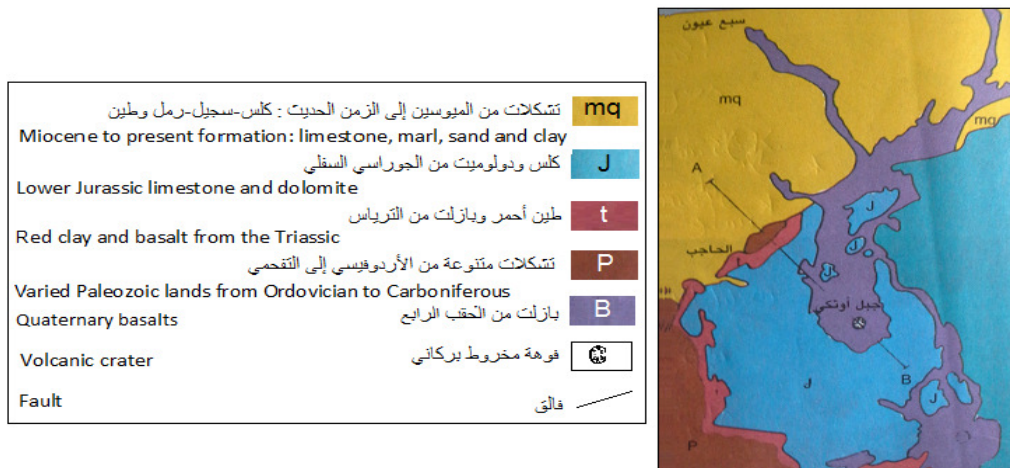
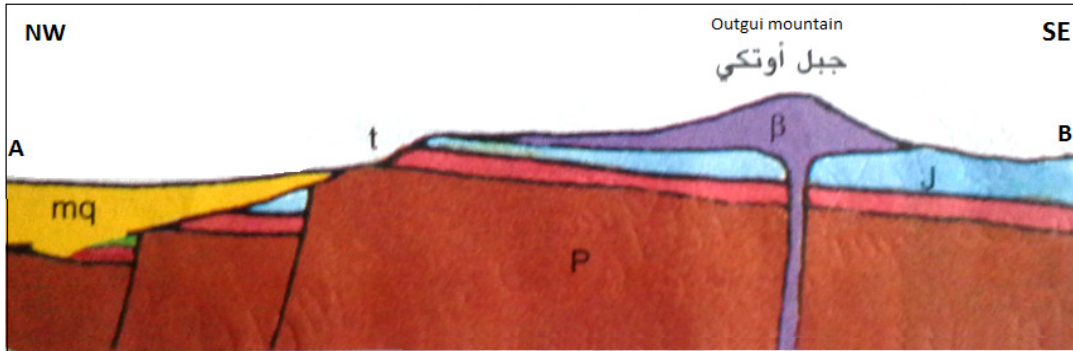


Fig. 2. Geological map showing the location of the Outgui mountain in the Middle Atlas

**Table 1. Comparison of textbooks studied**

<b>Textbooks</b>	<b>El Massar</b>	<b>El Moufid</b>
Release Year	2004 to 2017	2004 to 2017
Language	Arabic	Arabic
Cycle	middle School	middle School
Teaching level	2 <sup>nd</sup> year	2nd year
Unit dealing with the volcano concept	Internal geological phenomena	Internal geological phenomena
volcano concept	<ul style="list-style-type: none"> <li>- differentiate between the two types of effusive and explosive eruptions</li> <li>- Specify the origin of the magma and the constituents of the volcano</li> <li>- know the relationship between the distribution of volcanoes and plate tectonics.</li> <li>- Understand the mechanism of ocean extension, subduction and plate tectonics.</li> <li>- Become aware of the gravity of volcanoes</li> </ul>	<ul style="list-style-type: none"> <li>- differentiate between the two types of effusive and explosive eruptions</li> <li>- To specify the types of eruptions characterizing the geodynamic contexts of extension and subduction.</li> <li>- know the relationship between the distribution of volcanoes and plate tectonics.</li> <li>- Realization of manipulations to understand the mechanism of volcanic eruption.</li> <li>- Produce synthetic layout.</li> </ul>
	Documents for questioning and data to exploit knowledge supplement	
	volcanoes: The Furnace and Pinatubo.	Volcanoes: the Furnace, Soufrière Hills and Saint-Helens.
	research and documentation about extinct Moroccan volcanoes. (p.35):	No information
volcanoes of the Middle Atlas	Space aims according to the space	No space No space
	<ul style="list-style-type: none"> <li>Formation of magmatic rocks.</li> <li>- Observation of basalt and granite samples to build the concept of magmatic rocks.</li> <li>- Determine the conditions of formation of magmatic rocks.</li> <li>- Training in the observation and classification of magmatic rocks.</li> <li>- Training in the observation and the realization of measurement and schema.</li> <li>-Sensitization to rational exploitation of natural resources.</li> </ul>	
	Iconographic content and number of pages	No space
	Content spread over three pages 48, 49 and 57: <ul style="list-style-type: none"> <li>- Text of two lines,</li> <li>- A portion of a geological map,</li> <li>-A geological section.</li> <li>-A panoramic view of basaltic rocks. (see Fig. 1)</li> </ul>	



**Fig. 3. Geological section of the Outgui mountain according to the AB segment in the map**

In our opinion, this proposed panoramic view could have been an opportunity to illustrate a volcano with an ancient cone associated with volcanic products materialized by basaltic rocks flush in this portion of ground.

The second image (Fig. 2) entitled geological map showing the location of Outgui Mountain and the third image (Fig.3), which represent a geological section along Outgui Mountain (section AB). On the comment we read: "Outgui mountain (is an extinct volcano whose last activity dates back to the Quaternary) and the valleys around it are made of basaltic rocks ...".

We notice that in this text proposed in Fig. (2) the authors refer to the "Outgui Volcano". However, in the same text and in the titles of Figs. 2 and 3 they report it as being a mountain.

In this context, it would be desirable to specify that this is a portion of the El Hajeb geological map at (1 / 100,000) and not a geological map showing the "Outgui volcano" and not the Outgui mountain. Indeed, in our previous work [19] and [20] and the work of Laperrière-Tacussel [33], Orange [34], learners and teachers of SVT define the volcano as a "mountain that spits fire".

However, it would be of great importance to use both photos from the field or from Google Earth of this volcano, in addition to the portion of the geological map and the geological section. Insofar as they constitute learning tools that are almost unfamiliar to the learners of this cycle. Such learners may encounter difficulties in finding themselves in front of these pedagogical tools that they really learn to use them, to refer to them, only later. This is in agreement with the work of Savaton [35], Boughanmi [36].

In our opinion, this Outgui volcano with its long lava flow, should have been treated during the

construction of the volcano concept of the effusive type.

#### 4. CONCLUSION AND RECOMMENDATIONS

This analyze textbooks in the field of geology generally remains a field little studied in Morocco by the didactics. In this study, we used the comparative analysis of two textbooks of the LES of the Moroccan secondary school published from 2004 to 2017 concerning the volcano concept related to the volcanic chain of the Middle Atlas. This analysis highlighted differences and some commonalities between the two manuals. Indeed, we found that:

- The content that deals with the concept of volcano in the two textbooks El Moufid and El Massar has not changed since 2004, the authors and editors of these textbooks, take this concept of previous editions, especially iconographic to keep them at the identical.

The total absence in these two textbooks of images in the form of distribution maps of extinguished volcanoes in Morocco in general or those of the volcanic chain of the Middle Atlas in particular (Annex I).

- These textbooks didn't fulfill their function of knowledge transmission, education and awareness of national or regional wealth in volcanic geosites.
- Beyond these common points, there are some differences such as:
- The textbook "El Massar" which deals in a short and superficial way a single volcano: Outgui in the concept of formation of the magmatic rocks and not that of the volcanoes.
- The same textbook, as part of the knowledge supplement related to the

concept volcano engages students and teachers in activities of investigation and realization from the research and documentation about extinct Moroccan volcanoes.

Since LES textbooks are basic documents for both learners and teachers, they need to be continually refined and evolved both to better adapt to the needs of users of any educational cycle and to greater scientific and educational rigor, taking into account the results of research in geology and didactics of geology.

As the improvement and evolution of textbook content could only be done following identification of gaps, and since the role of the textbook is undeniable in the transmission of the Moroccan volcanic heritage. We propose:

- To take into account the results of our modest research in curriculum development and textbooks. Our results provide useful insights for guiding editors and policy makers concerned with improving the quality of curriculum and textbooks. These results would also be useful for practitioners (LES teachers, LES pedagogical advisers).
- To link the results of the research of the didacticians, the academics relating to all the extinct volcanoes of Morocco and those of the volcanic chain of the Middle Atlas and the designers of the textbooks. The support of such manuals is a guarantee of success for the development of regional or national geological culture and for teaching, valorization and protection of this Moroccan geological heritage for future generations.
- To integrate the volcanic chain of the Middle Atlas in different textbooks, all cycles included.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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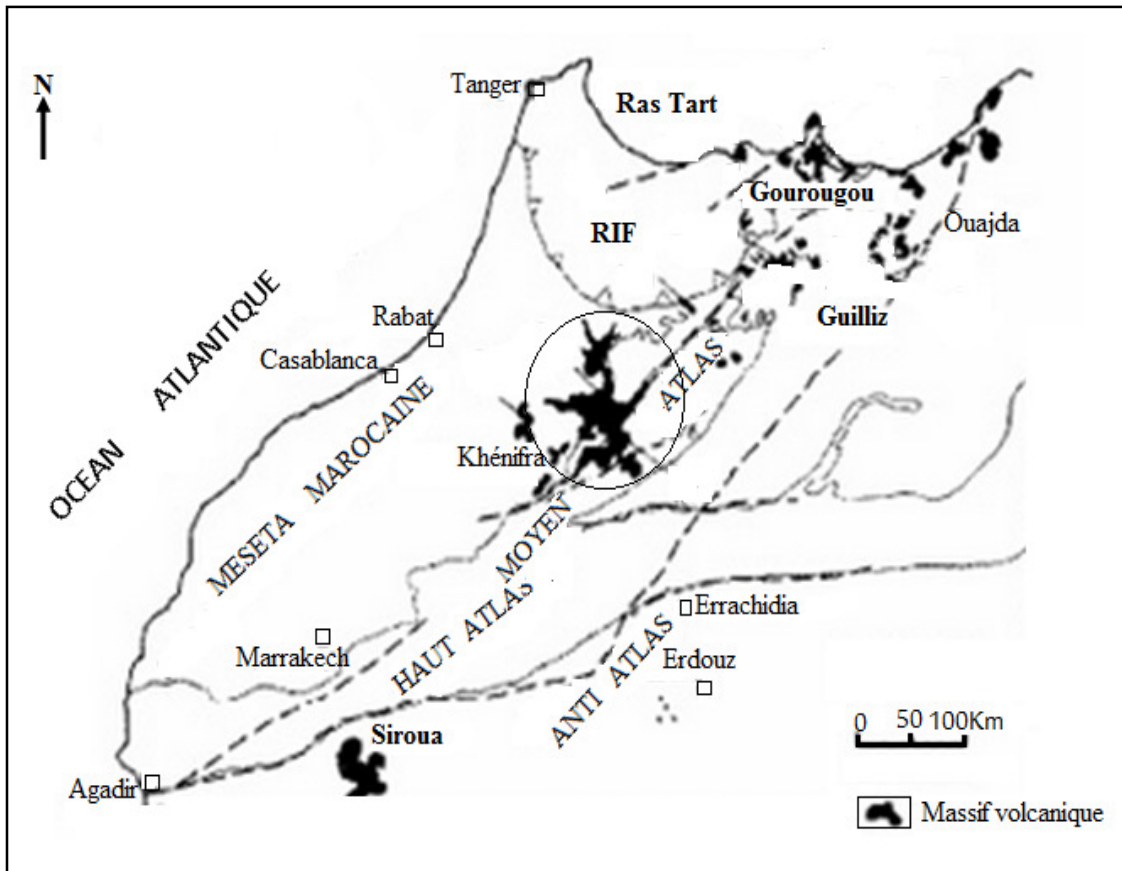
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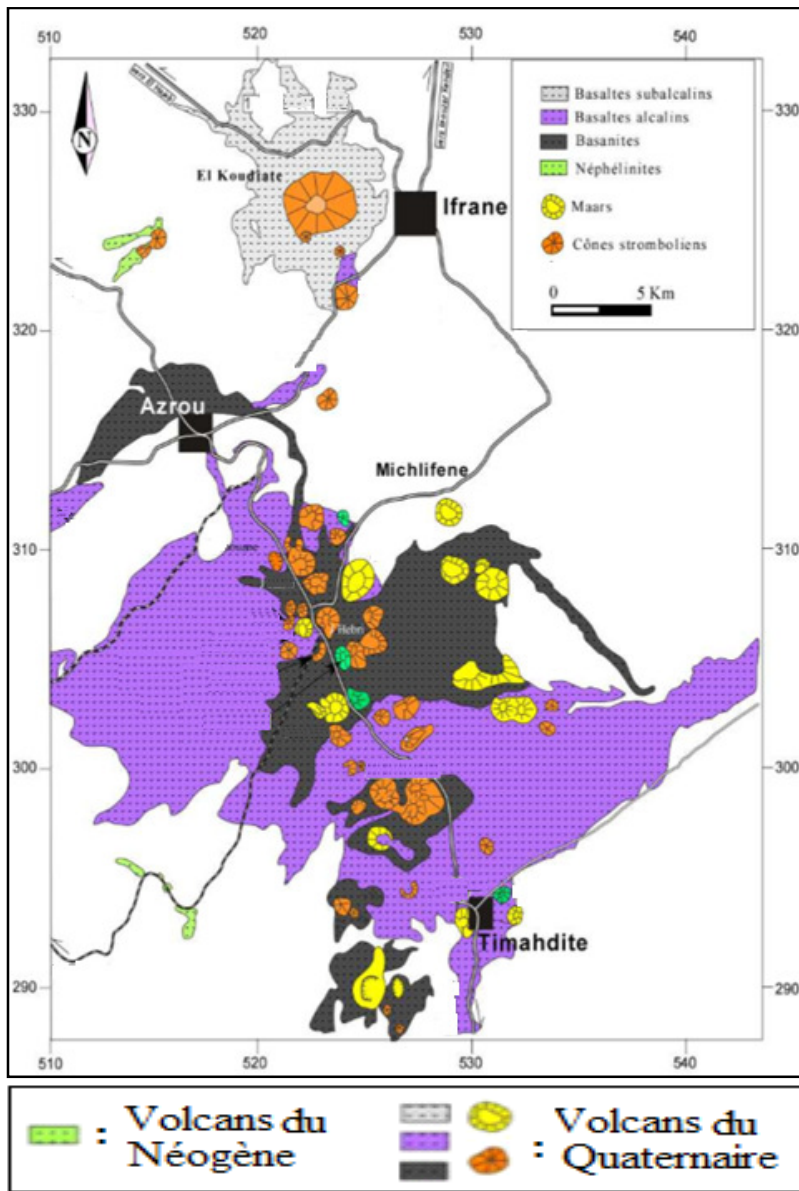
**Annex I. Analysis grid of both textbooks**

1. Fiche signalétique	title Author (s) Editor Release date Target population levels	El Massar Laaraj Azouz et al. [28] Nadia 2004 Teachers and learners 2nd year of middle School	El Moufid Sadki Abdelkade et al. [29] Dar Attaqafa 2004 Teachers and learners 2nd year of middle School
2. Description of the content of Moroccan volcanoes	Moroccan extinct volcanoes in general Volcanic chain of the whole Middle Atlas Iconographic content concerning the volcanoes of the Middle Atlas  space of this content in the manual	as part of the knowledge supplement (p.35): research and documentation about extinct Moroccan volcanoes Absent  - Panoramic view of an unnamed volcano (p 48) - A portion of a geological map showing the outgui volcano. (49) - Geological section showing volcano outgui. (49) - Text of two lines (pages 49 and 57). Concept de formation des roches magmatiques.	absent  absent  No content  No space
3. Aimes		- identify the structure of basaltic rocks. - Specify the formation mode of the basalts.	No aimes

**Annex II. Extinct volcanoes of Morocco with detail of those of the middle atlas**



**Distribution of Neogene and quaternary volcanism in Morocco (El Azzouzi et al. [32])**



**Petrographic map of the different volcanic units of the Middle Atlas (El Azzouzi et al. [32])**

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