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# FORMATION OF THE SIDI BOU OTHMAN PEGMATITES, CENTRAL JEBILLET (MOROCCO)

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***Abstract*** – This work represents an in-depth study of the relationship between the emplacement of pegmatites in the Sidi Bou Othman region, at the heart of the Jebillet massif in Morocco, and the geodynamic model. This research is based on the results of a detailed analysis of thin sections derived from samples collected at the study site.

The Jebillet massif, which underwent Hercynian orogeny, gave rise to magmatic intrusions, including the Oulad Ouslam granite. The latter is known to be responsible for the formation of pegmatites in the Sidi Bou Othman region. However, the precise understanding of the geodynamic mechanisms involved in their emplacement remains an active area of research.

In this study, we focused on a thorough analysis of thin sections from samples obtained from various locations within the study site. This approach allowed us to observe and characterize the properties of the constituent minerals of the pegmatites, as well as their microstructural organization.

The obtained results have revealed crucial information about the conditions of formation and evolution of the Sidi Bou Othman pegmatites. Microscopic examination of the surrounding schist rocks revealed that the region underwent three deformation phases, namely, D0, D1, and D2, confirming the deformation model proposed by Huvelin, 1977, and El Hassani, 1992.

*Keywords – Pegmatite, Geodynamic Model, Jebillet, Thin Section*

## I. Introduction

Pegmatites, intriguing geological formations renowned for their extraordinary mineral diversity and economic significance, have captivated the curiosity of scientists for a considerable period, driving a quest to unravel the mysteries surrounding their origin and emplacement processes. This article embarks on a comprehensive exploration, focusing on the Sidi Bou Othman region situated within the Jebillet massif in Morocco. Our research is dedicated to illuminating the intricate relationship between the emplacement of pegmatites in this area and the underlying geodynamic model.

In our pursuit of understanding, we conduct an in-depth analysis of thin sections derived from samples collected at the study site, aiming to unveil valuable insights into the formation and evolutionary history of these enigmatic pegmatites. The journey commences with an exploration of the geological context of the Jebillet massif, which has undergone Hercynian orogeny, giving rise to magmatic intrusions, notably the Oulad Ouslam granite, a pivotal player in the genesis of the Sidi Bou Othman pegmatites.

Our study area is an integral part of the Sarhlef schists of Upper Visen-Namurian age. This geological series is characterized by significant syn-schist deformation and regional anchi to epizonal metamorphism, as documented by Huvelin in 1977 [7]. This metamorphism is locally associated with a halo of contact metamorphism around granitic intrusions. Within these Visean terrains, pre-orogenic magmatic effusive rocks found their emplacement.

Through this study, we aim to contribute to the broader understanding of pegmatite formation by integrating geological context, mineralogical analyses, and insights derived from the emplacement history. The Sidi Bou Othman region serves as a compelling case study, offering a unique opportunity to delve into the geological intricacies that shape these remarkable geological features.

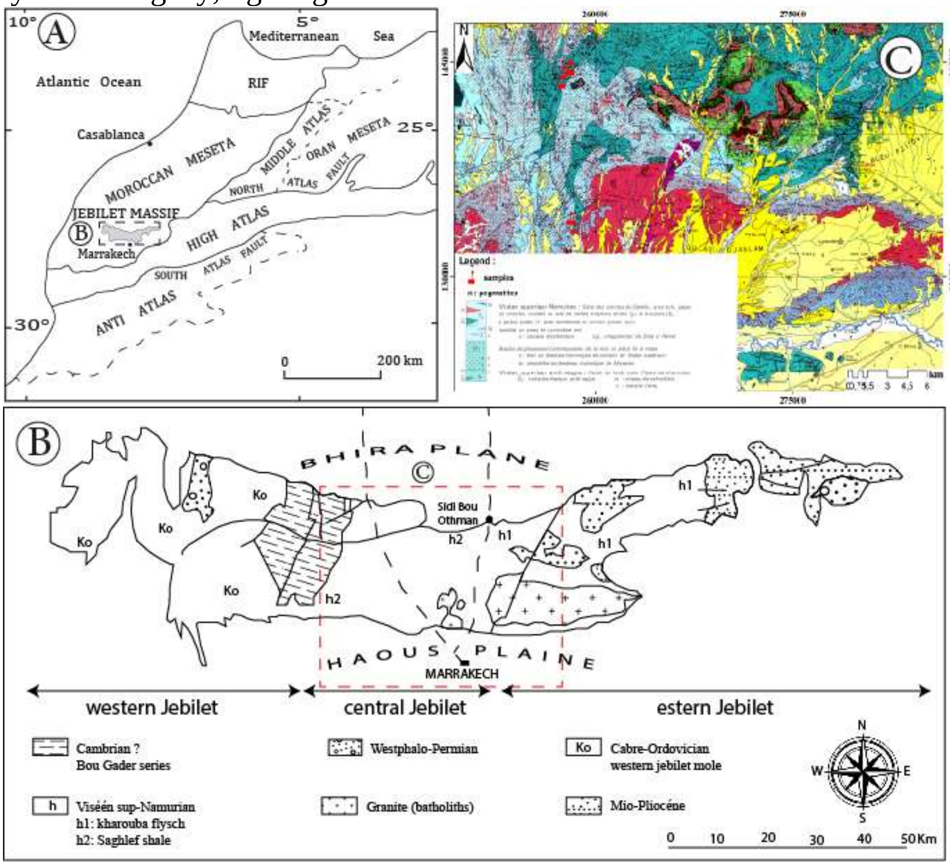


Fig 1: Location map of the study area. A- situation of the jebillet massif. (the northern part of morocco). B- decoupage of maasif jebillet. C- geological map of central jebillet [7]

## II. Materials and Method

Our methodology is based on an intensive day in the field, during which we collected measurements and took representative samples. Our work then continued in the laboratory, where we paid particular attention to the preparation of thin sections. This crucial step required extreme precision to guarantee the quality of the samples examined. Finally, we carried out an in-depth analysis on the prepared slides, enabling us to obtain significant and informative results for our study.

### A. *Field day*

One field day was devoted to collecting pegmatite samples. Field equipment included geological tools such as hammers, compasses and field notebooks to record in situ observations. Sample locations were carefully documented using a georeferencing system (GPS).

### B. *Samples collection*

Representative pegmatite samples were collected in the field at strategic locations, taking into account lithological variations and local geological structures. Samples were collected in accordance with best geological sampling practices to ensure the representativeness of the specimens collected.

### C. *Preparation of thin sections*

Back in the laboratory, samples were prepared for analysis under a polarizing microscope. Samples were cut into thin sections of standard thickness. These were then mounted on glass slides and polished to a smooth, flat surface. The thin slides were carefully prepared to guarantee the quality of observations under the microscope.

### D. *Analysis under a polarizing microscope*

The prepared thin sections were analysed under a polarizing microscope to study the mineralogy of the pegmatites. Cross-polarization was used to identify the constituent minerals and observe the textural characteristics of the samples. The optical properties of the minerals, such as birefringence, were evaluated to obtain information on the formation conditions of the pegmatites.

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## III. Results

The site features an outcrop of schists affected by schistosity planes oriented S1: N25-25NNW, and parallel to these schistosity planes is a lens of post-orogenic pegmatite (unaffected by schistosity). Upstream are metamorphosed limestones (skarnes).


Fig 2: field photos

A sample taken from the centre of the lens reveals phenocrysts of tourmaline, muscovite, plagioclase, biotite K and quartz. Tourmalines are rhombohedral and automorphic, with greenish zonation and transverse breaks. Muscovites occur as large automorphic lamellae, plagioclases as rectangular tablets with polysynthetic macles, biotites are rectangular and quartz crystals are sub-automorphic with rolling extinction. The mineralogical composition of this generally automorphic slide confers a pegmatitic texture, reflecting a primary mineralogy formed during moderately slow cooling. Zircon inclusions and small late quartz crystals, resulting from residual liquid crystallization, are also present in this slide.

Microscopic study of the host rock reveals a paragenesis composed of quartz, biotite, muscovite and andalusite. The rock has a lepidoblastic structure, with lamellar biotite and muscovite crystals arranged parallel to one another, following the direction of the schistosity plane. Andalusite ($Al_2SiO_5$) is a high temperature, low-pressure mineral that characterizes contact metamorphism, reflecting the emplacement of a batholith (magmatic intrusion). In the plate, andalusite appears as poecilitic nodules that enclose pre-existing minerals during its growth, testifying to rapid crystallization. This andalusite has a rotated appearance, indicating the presence of shear stress subsequent to their formation.

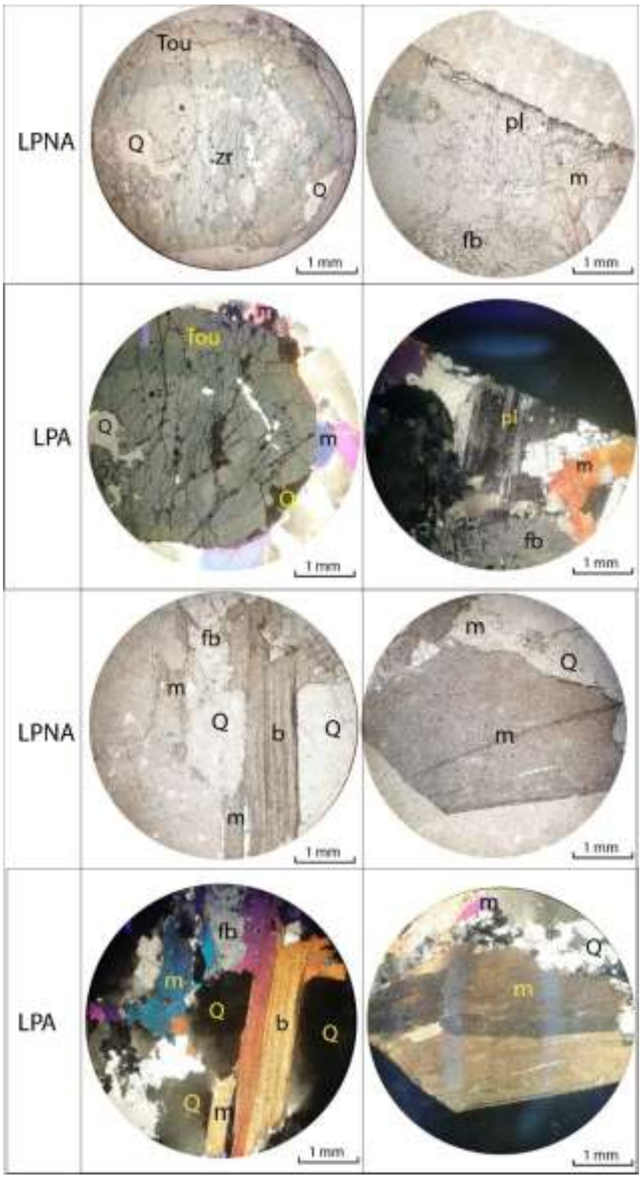


Fig 3 : microscopic view of pegmatite (Q: Quartz, m: muscovite, b: biotite, fb: feldspar, Tou: tourmaline, pl: plagioclase, Zr: Zircon)

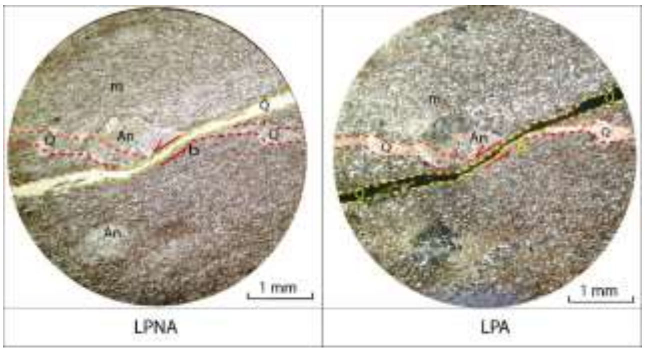


Fig 4 : microscopic view of shale bedrock (Q: quartz, b: biotite, An: Andalusite, m: muscovite)

## IV. DISCUSSION

The findings from the study of thin sections reveal a discernible chronology that aligns with the proposed deformation model for the central Jebillet region, specifically the formation of Sidi Bou Othman. According to Huvelin (1977) [7] and El Hassani (1992) [3], the Sidi Bou Otman underwent three phases of deformation: the pre-schist deformation (D0), the major deformation (D1), and a third late deformation phase (D2).

The presence of andalusite crystals is linked to the emplacement of the Oulad Ouslam granite batholith, dated at 327 Ma (El Amrani and El Hassani, 1996) [3]. This granite originates from the intrusion of a basaltic magma at depth, which melted the continental crust, giving rise to an acidic magma. The emplacement of this granite is interpreted as associated with a distension domain, potentially corresponding to a back-arc basin. After the cooling of the granite magma, residual liquid infiltrated fractures, giving rise to the pegmatites of Sidi Bou Othman and a set of quartz veins.

Andalusite minerals appear as poikilitic nodules, with the beginnings of the individualization of dark bands forming micas oriented along the schistosity plane, and clear bands of quartz. This suggests that these minerals underwent deformation after their initial formation. This deformation phase is indicated by the presence of a vein family subsequently filled by quartz. A second deformation phase is characterized by the presence of a second vein family that affected the first family.

The correlation between the pre-schist deformation and the emplacement of the Oulad Ouslam granite, developing a contact metamorphism aureole responsible for andalusite formation, is evident. Subsequently, a second deformation phase imparted a rotational aspect to the andalusite, also giving rise to the initial vein families. Finally, a third deformation phase (D2) is identified as responsible for creating the second vein family, cutting across the first. These observations provide a nuanced understanding of the deformation history associated with the formation of Sidi Bou Othman and contribute to the broader comprehension of the geological processes at play in the Jebillet region.

## V. CONCLUSION

In conclusion, our detailed investigation into the geological complexities of the Sidi Bou Othman region within the Jebillet massif has yielded valuable insights into the formation and deformation history of the pegmatites in this area. The integration of thin section studies has allowed us to unravel a chronological sequence that aligns with the proposed deformation model for the central Jebillet region.

The identification of three distinct deformation phases (D0, D1, and D2) in the formation of Sidi Bou Othman, as outlined by Huvelin (1977) [7] and El Hassani (1992) [3], provides a robust framework for understanding the geological evolution of this region. The association between the andalusite crystals and the emplacement of the Oulad Ouslam granite batholith, along with the subsequent phases of deformation, adds depth to our comprehension of the intricate processes that shaped these pegmatites.

The observed mineralogical features, including poikilitic nodules, oriented micas, and quartz veins, offer compelling evidence of multiple deformation events impacting the andalusite-bearing rocks. The interplay between these phases of deformation and the magmatic history, particularly the granite intrusion, underscores the dynamic geological processes at play in the Sidi Bou Othman region.

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