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RICHNESS IN POLYMETALLIC MINERALISATION Fe, Pb, Zn, Ba AND HYDROTHERMAL SPRING OF MOUNT M'CID AICHA, TELLIAN ATLAS, NORTH-EAST OF ALGERIA

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Abstract: *The massif of M'cid Aïcha is located in Tellian Atlas in the north-eastern of Algeria. This mountain chain is made up extrusions of Triassic gypsiferous formations and Jurassic carbonate, which contain polymetallic mineralization (Zn, Fe, Pb, Cu and Ba) and hydrothermal spring. The region is affected at the north by magmatic events. The structure is a set of anticlines and synclines of E-W direction delimited at the north and south by longitudinal faults; it is also affected by transverse meridian faults rich by a mineralisation. The hydrothermal spring localized in the intersection of the main tectonic accidents. The formation characterises a shallow sea environment. TheM'cid Aïcha deposit was once mined for their zinc ore in the form of calamine. However, the rare gitological work carried out on these two gites has described polymetallic mineralisation with Fe, Pb, Zn, Cu, Ba expressed as sulphides(galena, sphalerite, pyrite, covellite and gray copper), oxides and hydroxides (haematite, goethite and limonite), sulphate (baryte) and carbonates (cerusite, malachite and azurite). This concentration shows a form of clusters,pockets, veins and lenses of very modest dimensions.*

Keywords: *M'cid Aïcha, Lias, mineralization, polymetallic, carbonate, Hydrothermal*

INTRODUCTION

The northeastern of Algeria is characterised by the great existence of polymetallic mineralisation due to the great propagation of carbonate massifs. The massif of M'cid Aïcha is one of these massifs which conceals polymetallic mineralisation in Zn, Pb, Fe, Ba. It is part of a group of massifs that also contains polymetallic mineralisation like the massifs of Sidi Marouf, Tissimiran (Kef Boulahmam), Kef Dardja and the sector of Boudjoudoun. All these massifs are located in a regional geological context that is a key to understanding the events that built this portion of the alpine chain of northern Algeria or the Maghrebian chain. On the geological level, [1] gave the first study of M'cid Aïcha and Kef Sema in which he pointed out the presence of the Lias in the M'cid Aïcha massifs. This study was followed by several geological and structural studies such as [2, 3, 4, 5 and 6] where the last gave a good lithostratigraphic and structural description of the M'cid Aïcha massif. On the mining level, the M'cid Aïcha deposit was exploited during the period from 1910 to 1914 by the "Société anonyme des mines et fonderies de zinc de la Vieille-Montagne". During this period,
this company extracted 3374 tons of ore in the form of pockets of calamine with 40/55% zinc after

calcination [7]. In 1975 the geological engineer C. Popescu of SONAREM (National Society of Research and Mining) describes mainly the iron ore mineralisation and specifies the outcrop areas, the morphologies of the mineralised bodies and their relations with the tectonics. The petrographic and mineralogical aspects of the mineralisation and their Jurassic host of M'cid Aïcha are described by [8 and 9]. In these pages we try to make a synthesis on the previous works in order to highlight the mineralisation of the M'cid Aïcha and it is through the most recent gitological works.

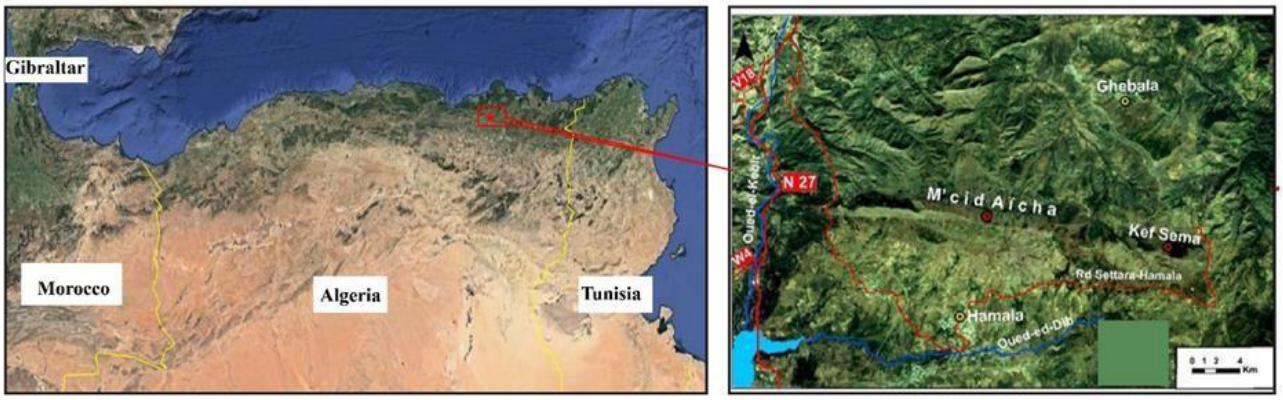

Figure 16. location of the massif of M'cid Aïcha

MATERIALS AND METHODS

Of all the other massifs of the numidic chain, the only massif of M'cid Aïcha which has not yet been well studied from a gitological point of view. However, due to the circumstances in which this work was carried out, the initial objectives were revised. Thus, given the impossibility of carrying out field and laboratory work, this characterisation was based much more on the work already carried out on the M'cid Aïcha massif. Unfortunately, these are not numerous. We have therefore called upon the old works of [5 and 6] which are monographs of a regional nature and more recent works carried out within the framework of university theses [8 and 9].

RESULTS AND DISCUSSION

Petrographic description of the carbonate rocks of M'cid Aïcha

Using the works of [5 and 6] we can subdivide the carbonate strata of M'cid Aïcha into three members, while from the works of [8 and 9] we can distinguish some petrographic aspects of these rocks.

1. The lower set

The lower set mainly forms the west side of M'cid Aïcha with an average thickness of about one hundred metres. It is essentially constituted by compact dolomitic rocks of greyish to brownish colour affected by cracks filled by iron oxides attributed to the Sinumerian. Microscopically, this facies shows greyish rhombohedral crystals with white patches. Microscopic cracks filled by iron oxides. These cracks intersect the crystals of the dolomites and this shows that the processes of fissuring and mineralisation are posterior to the genesis of the dolomite [6, 8] and 9] (Figure1 [1 and 2]).

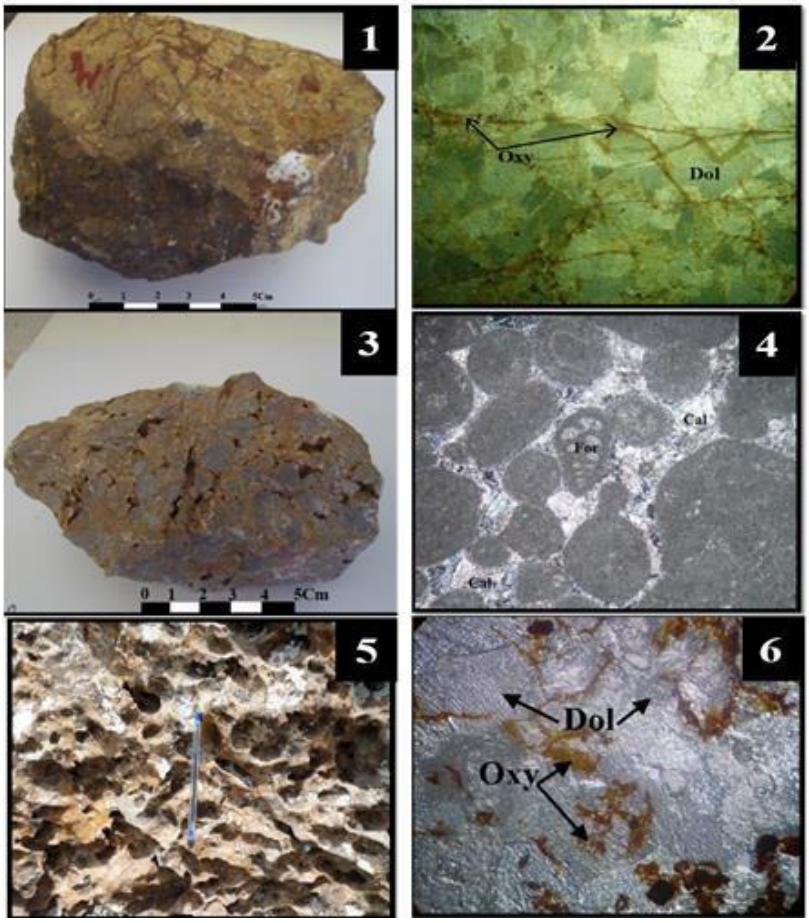

Figure 2. Macroscopic and microscopic appearance of carbonated rocks of M'cid Aïcha.
1/ Dolomitic limestone with cracks filled with iron oxides. 2/ Medium-grained dolomite. 3/ Brecciated limestone invasion of karsts and voids by a combination of iron oxide and calcite. 4/ Grainstone with foraminifera. 5/ Limestone bank surface showing karst cavities. 6/ Medium-grained dolomite with cracks filled with iron oxides (according to [8 and 9]).

2. The middle set

The middle set shows the largest part of the M'cid Aïcha massif, its thickness reaches up to 300m. They are attributed to the Lower Lias-Pliensbachian [6]. It consists by brecciated limestones and bedded limestones of Lower Lias-Pliensbachian age. The brecciated limestones are generally greyish brown, porous, cavernous and fractured and the fractures are often filled by calcite. They show microscopically grainstone-like textures containing pellets and rare foraminiferal tests set by crystalline sparite [6, 8] and 9] (Figure1 [3and 4]).

3. The upper set

It consit by a sublithographic limestones with marly intercalations that become more and more numerous towards the top of this unit. The thickness of this limb reaches up to 120 m. It is made up of sublithographic limestones with marly intercalations that become more and more numerous towards the top of this unit. The thickness of this limb reaches up to 120 m. All these facies are of Domero-Toarecian age. This limb is characterised by outcrops in the form of an elongated E-W "blade" at the level of the ridges in the M'cid Aïcha massif. The limestones are greyish in color and present specific dissolution surfaces and karstic cavities of variable size. Microscopically these limestones are of grainstone type. They contain foraminifera, fragments of lamellibranches, various indeterminable bioclasts and oolites set by a crystalline sparite. They often show dense microfracturing filled by calcite and iron oxides [6, 8] and 9] (Figure1 [5and 6]).

Mineralization
Two types of mineralisation exist at M'cid Aïcha: an iron mineralisation and a polymetallic mineralisation with Zn, Pb, Cu and Ba.

1. Iron mineralisation
Fifteen outcrops were identified by [10] in the northern edge of the M'cid Aïcha massif but only seven (07) were briefly described (Table 1). The seven outcrops have a vein morphology characterised by openings from 0.5 to 15 m and extensions between 15 and 100 m and controlled by the NNW-SSE and NNE-SSW transverse faults. Other iron mineralisation is found in the western part of M'cid Aïcha takes the lenticular form with dimensions among from 0.5 and 1.5 m and also the form in clusters present metric dimensions (5 to 15 m) (table 1). In the case of vein morphology and cavity filling the relationship between the ore and the host is regular while in the case of lenticular and cluster morphology this relationship is irregular. It is constituted by iron oxides and hydroxides (hematite, goethite and limonite). The hematite presents itself witha steel grey colour more rarely with reddish colors and shows a sub-metallic luster with a massive texture. Goethite is often blackish in color and has a massive concretionary or mamelonitic texture (fig.3 [1 and 3]). Limonites are mixtures of iron hydroxides that appear yellowish in color and are characterised by a very fine-grained granular texture. Under the microscope, hematite shows greyish-white tones with a medium reflectivity and a clear anisotropy in greenish-grey hues. It often shows frequent reddish internal reflections. Goethite appears with grey-blue tones and shows a clear anisotropy in bluish tones [8 and 9] (Figure 3 [2and 4]).

2. Polymetallic mineralization
The M'cid Aïcha massif contains polymetallic mineralisation, especially zinciferous in the form of calamines with related metals (Pb, Cu, Ba). This deposit, located in the eastern part of the massif seems to be formed by two lenses of smithsonite hosted in the liasic limestones. This mineralisation consists mainly of sulphides (galena, sphalerite and copper), sulphates (barite) and carbonates (azurite and malachite). All of these minerals have a massive texture. Galena, sphalerite and barite are often associated with each other. Galena isgrey to metallic luster with a tabular texture, sphalerite has apparently not been observed macroscopically, barite is yellowish-white with tabular crystals. The copper is often altered and give greenish malachite and bluish azurite (fig.4 [1 and 2]). Microscopically, galena occurs with whitish tones and always showstriangular pullouts, sphalerite often appears as large xenomorphic to automorphic patches and shows dark grey tones with low reflectivity, coppers occur as sub- automorphic to xenomorphic patches of greyish-whitecolor with medium luster [8 and 9] (Figure 4 [2and 4]).

Table 1. Nature and dimensions of iron occurrences of M'cid Aïcha massif (according to [10])

Occurrence	Nature	Dimension	Direction	Dipping
01	Limonitised limestone	50 x 10 = 500 m^2	N140E	60SW
04	Limonitised limestone	10 x (~4) = ~ 40 m^2	N10E	70ESE
10	Iron hydroxide dotted with nests and veins of calcite and barite	50 x 3 = 150 m^2	N180E	80W
11	Limonitised limestone and nests of iron hydroxide and barite.	150 x 100 = 15000 m^2	N180E	85W
12	Limonite, goethite and nests of barite and calcite	50 x 10 = 500 m^2	N165E	80ENE
14	Cavernous limestone Limonitised	100 x 5 = 500 m^2	?	?
15	Limonitized limestone with nests of Limonite	50 x 15 = 750 m^2	N80E	70S

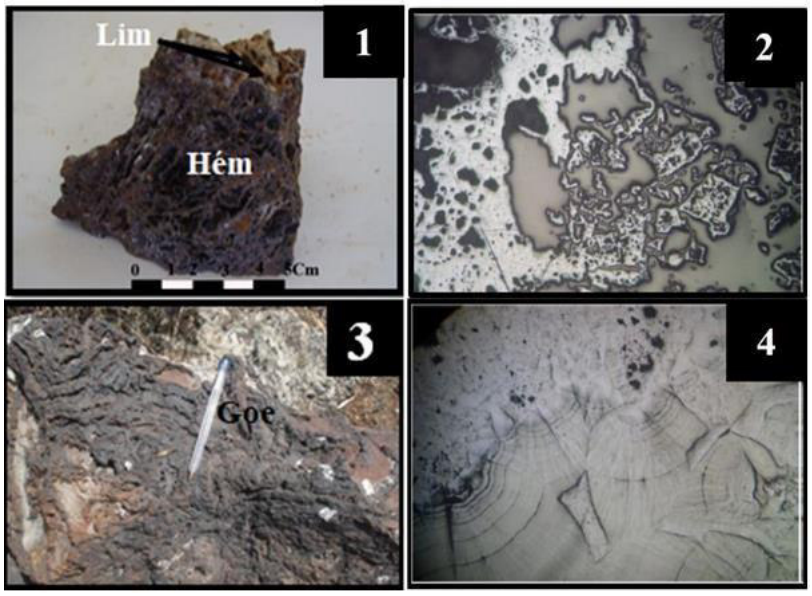

Figure 3. Macroscopic and microscopic appearance of iron mineralisation: (Hém) Hematite; (Goe) Goethite; (Lim) Limonite (Acording to [8]and [9]).

Comparison between the mineralization of M'cid Aïcha and the mineralizations of other massifs of the Numidic chain

In the western massifs of the Numidic chain of M'cid Aïcha massif contains various Fe, Zn, Pb, Cu and Ba mineralizations. Iron oxide and hydroxide iron mineralisation sometimes occupy alone the mineralised sites, it may also contain barite and are sometimes associated with base metal mineralisation (Zn, Pb).

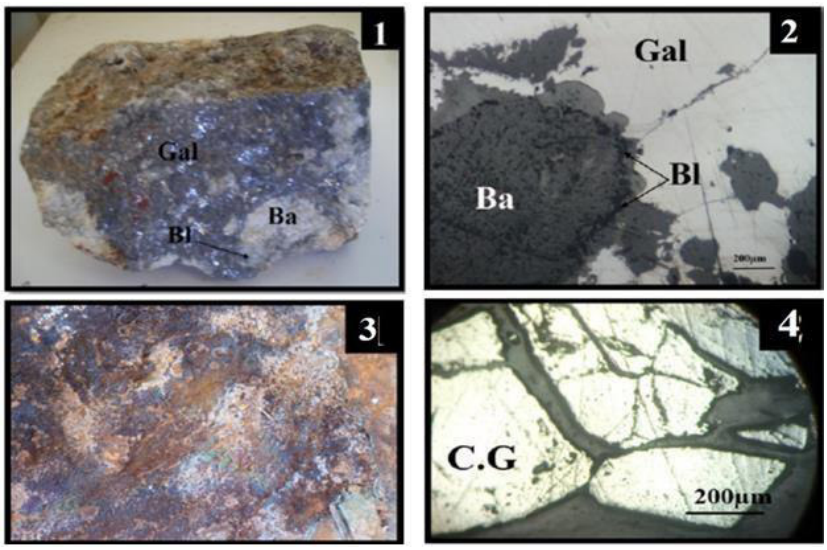

Figure 4. Macroscopic and microscopic appearance of polymetalic mineralisation. (Gal) Galena; (Bl) Sphalerite; (Ba) Barite; (C.G) Copper (Acording to [8]and [9]).

The cases of their spatial individualization allow to integrate them in a paragenesis independent of the other mineralizations. The massif of M'cid Aïcha and Kef Sema have a great variety of mineralizations compared to the other massifs of the Numidic chain. The Sidi Marouf massif contains only iron mineralisation with some trace of grey copper [11, 12, 13, 14, 15 and 16].

Tissimiran massif contains iron mineralisation with grey copper mineralisation [14, 17]. The Kef Darja massif contains only copper-barytic mineralisation [14, 18]. The mineralisation of M'cid Aïcha is hosted in carbonate rocks of the Lower Lias, as is the case in all the massifs of the Numidian chain [8, 9, 15 and 16].

These carbonate rocks range from Sinumerian to DomeroToarcian [6]. The iron mineralisation existed in the massif of Kef Sema, Tissimiran and Sidi Marouf. It has a lenticular morphology, lenticular and in clusters in the massif of M'cid Aïcha and Kef Sema [8, 9 and 10]. In Tissimiran it comes only in vein or in clusters [10, 14 and 17]. In the massif of Sidi Marouf, it is in the form of clusters, veins or nests [10, 12, 14, 15 and 16]. The iron mineralisation is more numerous and of greater size in the Sidi Marouf massif than in the other massifs [10]. It is always represented by oxides and hydroxides (hematite, goethite and limonite). The Plombo-Zinciferous mineralisation is found only in the massif of M'cid Aïcha and Kef Sema.

CONCLUSIONS AND RECOMMENDATIONS

The massif of M'cid Aicha consists by three carbonate liasic sets from the Sinumerian to Domero-Toarcian. This massif also contains iron occurrences in the form of oxides and hydroxides. It has the same morphologies and textures in all the massifs. The iron mineralisation is controlled by transverse faults. Iron paragenesis is individual and prior to polymetallic paragenesis. The polymetallic mineralisation is composed of sulphides (galena and sphalerite and grey copper) with barite. All these minerals come in massive texture. Lead and zinc mineralisation is found only in the massif of M'cid Aïcha and Kef Sema.

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