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PALEOENVIRONMENTAL OF THE SENONIAN OF WANINA BASIN: AREA OF AÏT OURIR BASINS, MOROCCO

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ABSTRACT: The detailed sedimentological study of the Senonian in the Wanina basin of Aït Ourir basins attached to the northern slope of the High Atlas Marrakech, gave the deposit silty carbonato-evaporite, which are carried out in an environment of type sebkha where alternate phases of detrital inputs, under a hot and arid climate and in conditions of bridging favoring the installation of evaporite deposition, and the phases of carbonate deposits more marine installed under the action of a slight increase in sea level degenerating quickly, in an upper intertidal temporarily emerged. In general these carbonate benches mark to their surfaces a rupture of the sedimentation that is materialized by ferruginous hardened surfaces.

KEYWORDS: Marrakech High Atlas, Senonian, Sedimentation, Paleoenvironnement.

PRESENTATION

The study area belongs to the northern subatlasic area ***(Roch, 1939),*** and specifically to the area of Ait Ourir basins. It includes a Mesozoic post-Hercynian coverage pleated in wide synclines with flat and subhorizontal bottom, the flanks of these synclines are to steep slope sub-vertical related to the presence of faults. These lands have dragged during the main atlasic phase ***(Moret 1931, Vogel 1980, Ferrandini et le Marrec 1982)***. This slip was triggered off by the movements of the reverse faults, responsible for the surrection of the atlasic chain, and continued by gravity to the North North West.At the level of this work, we conducted a sedimentological study of senonian in Wanina basin ***(Fig.1)*** showing a santonian evaporite serie and another maastrichtian carbonato-phosphated ***(Algouti ; 1999, Algouti et al 2015, Hadach et al 2015).*** This latter is located at 39km south east of Marrakech, in the direction of OUARZAZATE. It is limited to the north and to the west by the Plain of Haouz, to the south by the Tasghimout south basin and to the east by the Adendim basin. Three cuts have been lifted, one is located on the slope NW, next to the Douar Wanina, the other two are located in the SE of the basin, in Jbel Ighriys ***(Fig.2, 3 et 4)***. In our study, the description of the three sections was global due to low lateral variation detected in our research. In effect, along the basin we note a continuous provision of the various deposits that do not show great faciologic variation.

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Fig.1 : Location of the study area. C1, C2, C3 : Cuts 1, 2 and 3.

SEDIMENTOLOGICAL STUDY OF THE SENONIAN

The Senonian of this region has been subdivided into four units U1, U2, U3 and U4 ***(Fig.5).***

Unit 1:

This unit U1 is based on the bar Cenomanian-Turonian. Its basal part is formed by a dolomitic carbonate bench of lenticular aspect, revealing the presence of horizontal lamins, undulating with holes of dissolution and bioturbation and showing a surface with a thin ferruginous crust ***(Fig.6 / Photo A et B).*** This basal part is carried out in an environment with inter-supratidal settings. The absence of organism is probably due to the unfavorable conditions related to a deposit in brackish water where can form a few algal sails in low hydrodynamics conditions. Periods of emersion are at the origin of dessiccations slots, vacuoles of dissolution, and ferruginous surfaces.

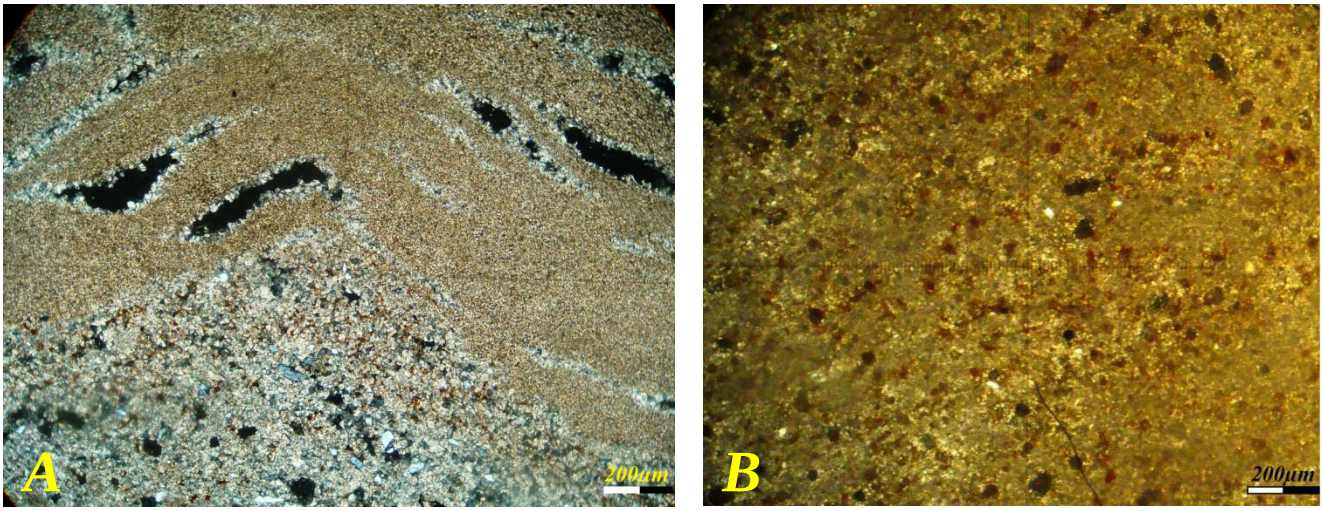


Fig.6 : A : Alternating clear levels and dark algal levels with the vacuoles of dissolution B : Micrite Mudstone Ferruginous.

Its upper part is formed by a term silt-Marl formed in a supratidal environment where precipitate evaporite crystals.

The basis of this unit translated a phase of advanced marine triggered either by a slight increase in the sea level, by a blow of subsidence, or by the two phenomena at the same time, this is accompanied by a relative bathymetric increase and therefore a slight transgression.

The Summit of the unit reflects the bridging of the environment in a supratidal zone.

Units 2, 3 and 4

Each unit begins with a metric bench of carbonate often dolomitic, not exceeding two meters thick, it is a dolomicrite to mudstone dolomicrosparite, sometimes showing an organization of alternating clear zones dolomitic and more or less detrital (silty) to fenestrae and dark area of ferruginenous micrite probably of algal origin. Generally these carbonate benches are of lenticular aspect showing several sedimentary figures: horizontal and wavy lamins, monogenic breccias sometimes associated to fenestrae, of stromatolites in the domes and tipis, bioturbation, holes of dissolution, microchannels, and erosive basis (for the unit u2). The surface of these benches is often ferruginous to lenses of goethite and/or of flint attesting to a sedimentation stopping and corresponding to a surface hardened.

Each unit ends by an alternation of silts more or less marly, reddish and gypsiferous with venules of secondary fibrous gypsum and benches of whitish gypsum of saccharoidal type often with laminated structure ***(Fig. 7 / photo A et B)*** and lenticular form. The morphoscopie of quartz grains in the silts has shown an abundance of round grains mats to shiny.

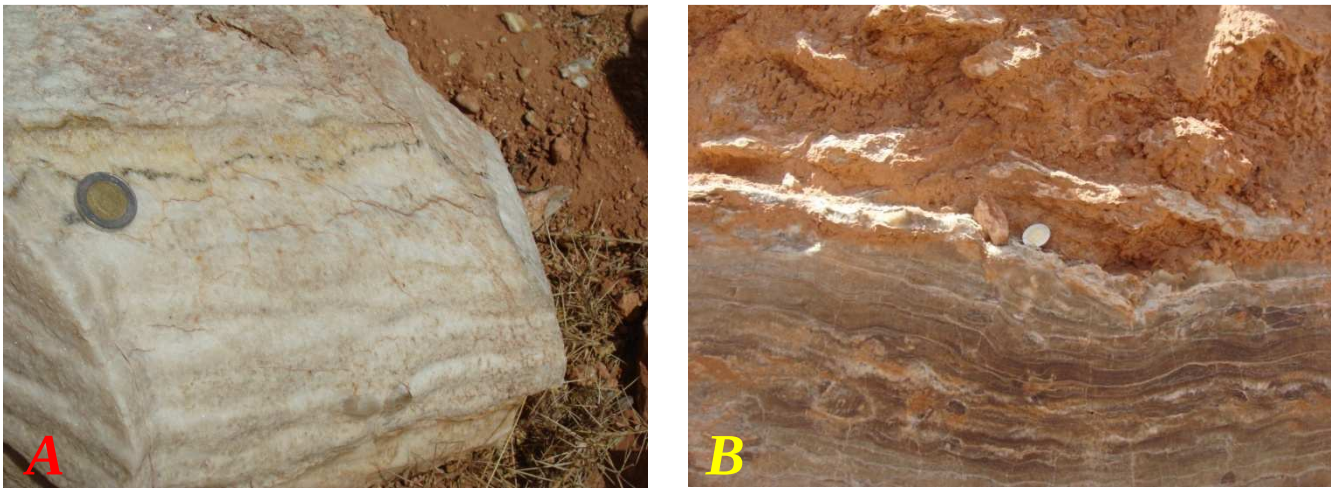


Fig.7: A : Saccharoidal whitish gypsum B : Gypsum of saccharoidal type with laminatedstructure

INTERPRETATION

The presence of the gypsum suggests an environment of sebkha type. Evaporites of our region belong to the capillary evaporites originating from preexisting sediment, the result of the brines concentration in subaerial conditions under an arid climate and during an early diagenesis. In addition, each gypsum episode reflects the passage of evaporite conditions by restriction of sedimentation and environmental containment ***(Toulement, 1980).***

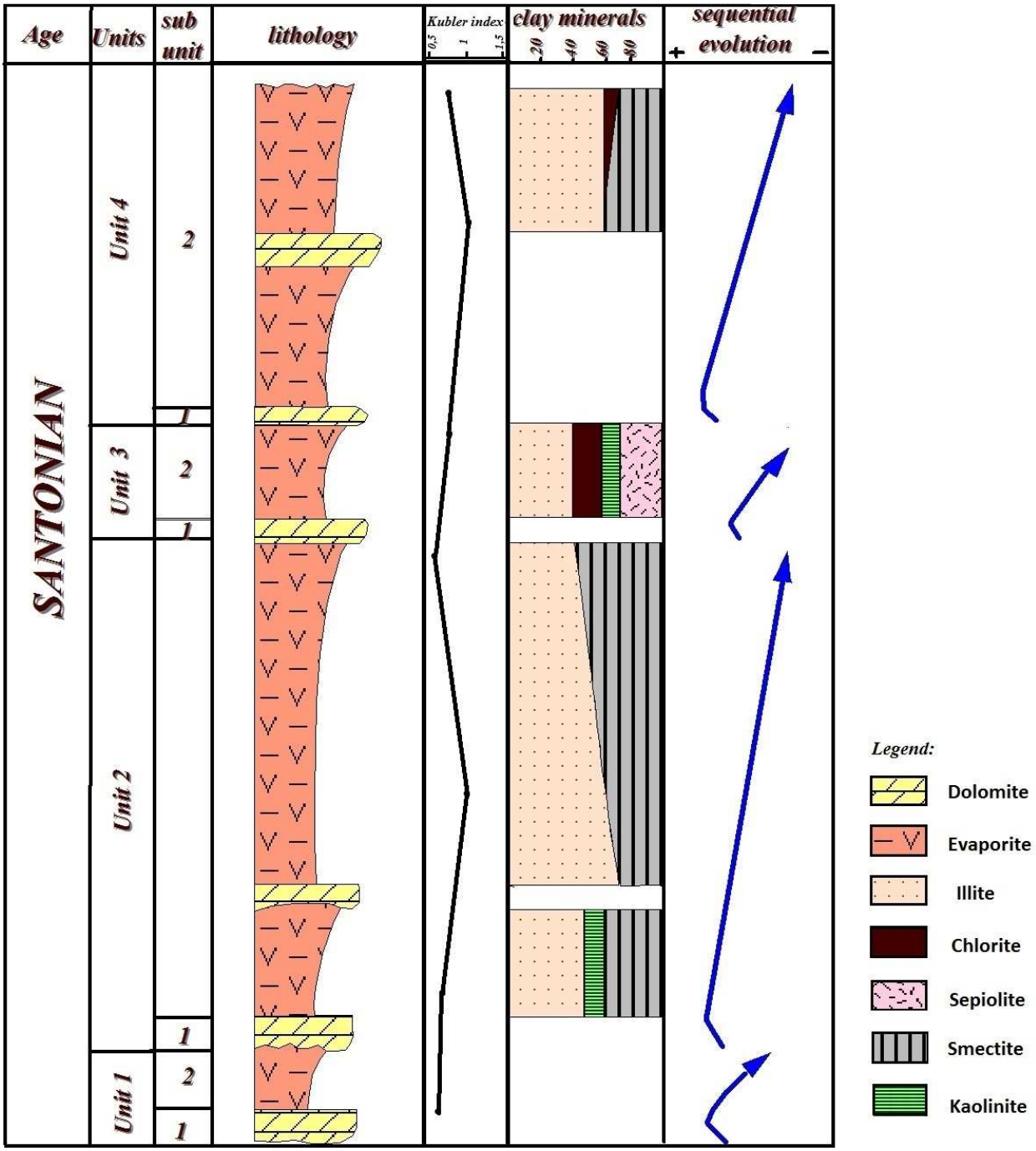


Fig.5 : lithostratigraphique Cut of Senonian at South East in the basin of Wanina.

After a careful review, the carbonates facies mentioned have given many structures recognizable, which have led us to define the environment of sedimentation. The latter represents a zone of internal shallow platform (intertidal to supratidal) Affected by phenomena of emersions, in a probably hot and arid climate. Indeed, the Association of birds eyes, the sheet cracks and the slots of desiccation detected at the level of these carbonates, characterizes a subaerial environment ***(Shinn A, 1968).***

In addition, the structures in tipis have been found in a micritic facies where the stromatolitic structures and the fenestrae are well developed. ***(Kendall and Skipwith, 1968)*** have described similar structures on the coast of Abu Dhabi. According to the (***Dresnay, 1976),*** these structures characterize the edge of the maritime domain, in an area temporarily emerged, under a warm and arid climate.

The monogenic breccias associated with carbonate levels are due to a dissolution of a evaporitic precursor, followed by a collapse. It is of an association of dissolution-collapse under the action of an emersion.

The microfacies of carbonates to stromatolites show a superposition of lamins rolling, reflecting a provision in dome, at the bench scale. It is an alternation of clear zones dolomitic more or less silty, accompanied by fenestrae, and dark areas of ferruginous micrite of algal origin. These structures are similar to the structure LLH (Lateraly linked hemispheroïdes) of (***Logan et al, 1974)*** characterizing an intertidal environment (tidal-Flat) protected and periodically emerged. Indeed, the different structures associated with these stromatolites (fenestrae, tipis…) argue in this sense.

As a conclusion, we could say that the sedimentation is carried out in an environment of type sebkha where alternate phases of detrital input, under a hot and arid climate and in conditions of containment favoring the installation of evaporite deposition, and the phases of carbonate deposit more marine installed under the action of a slight increase in sea level degenerating quickly, in an upper intertidal temporarily emerged. These carbonate benches mark in general to their surfaces a rupture of the sedimentation that is materialized by ferruginous hardened surfaces.

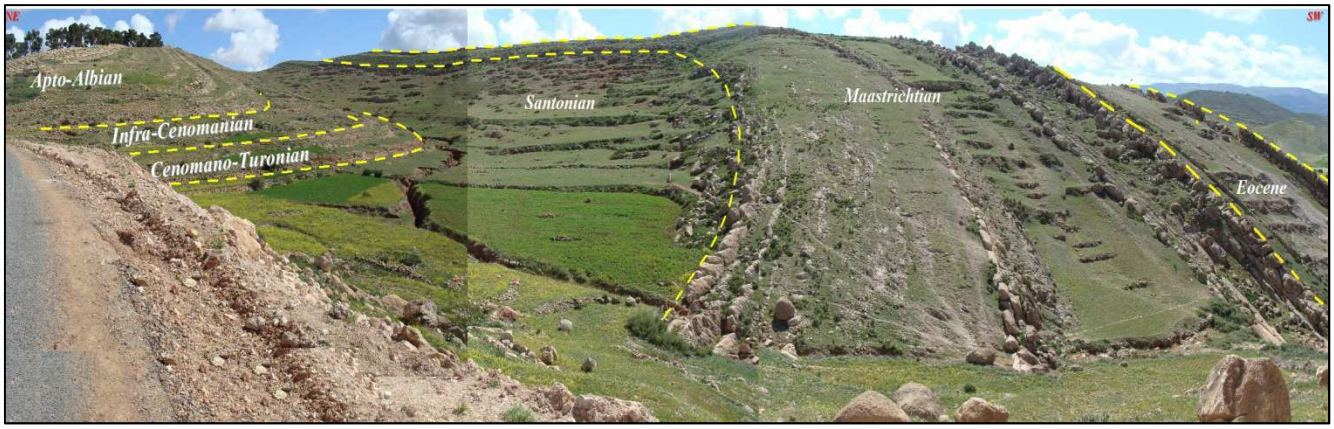
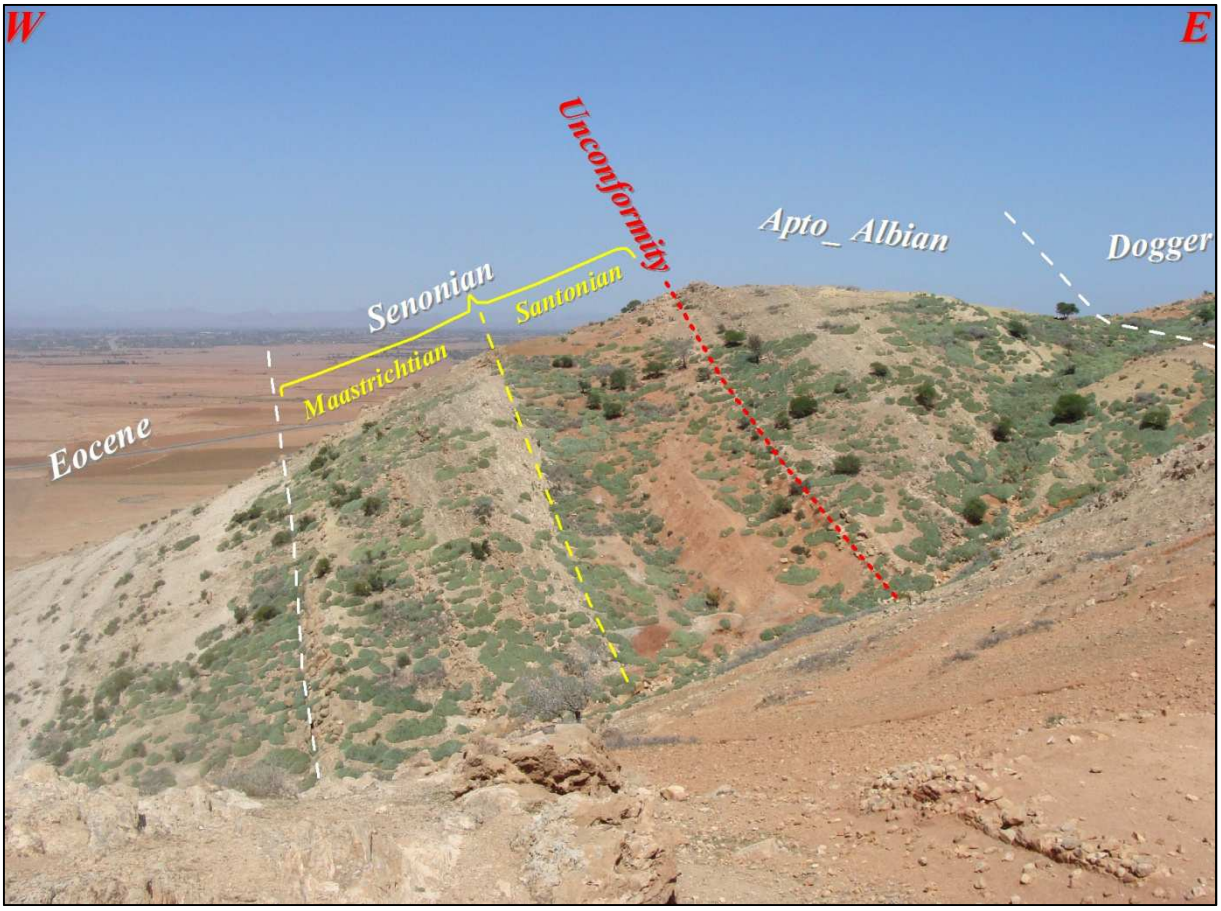


Fig.2 : Vue Panoramic view of the NW side



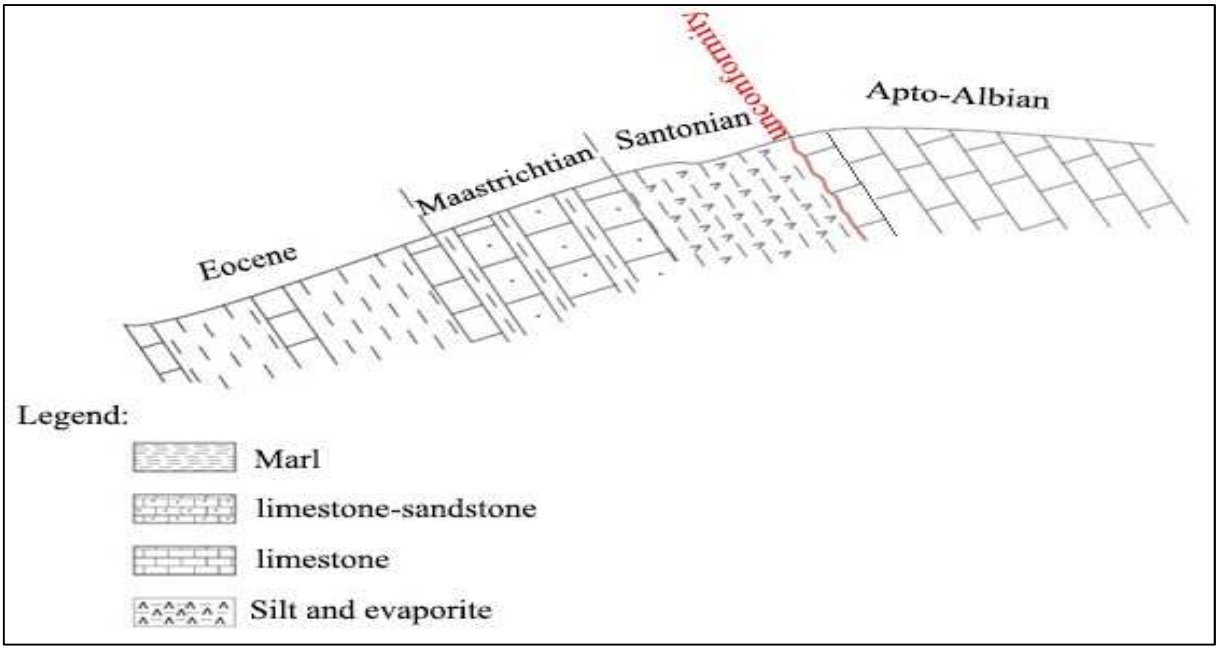


Fig.3 : Vue Panoramic view and geological section of the SW side with an inverse series

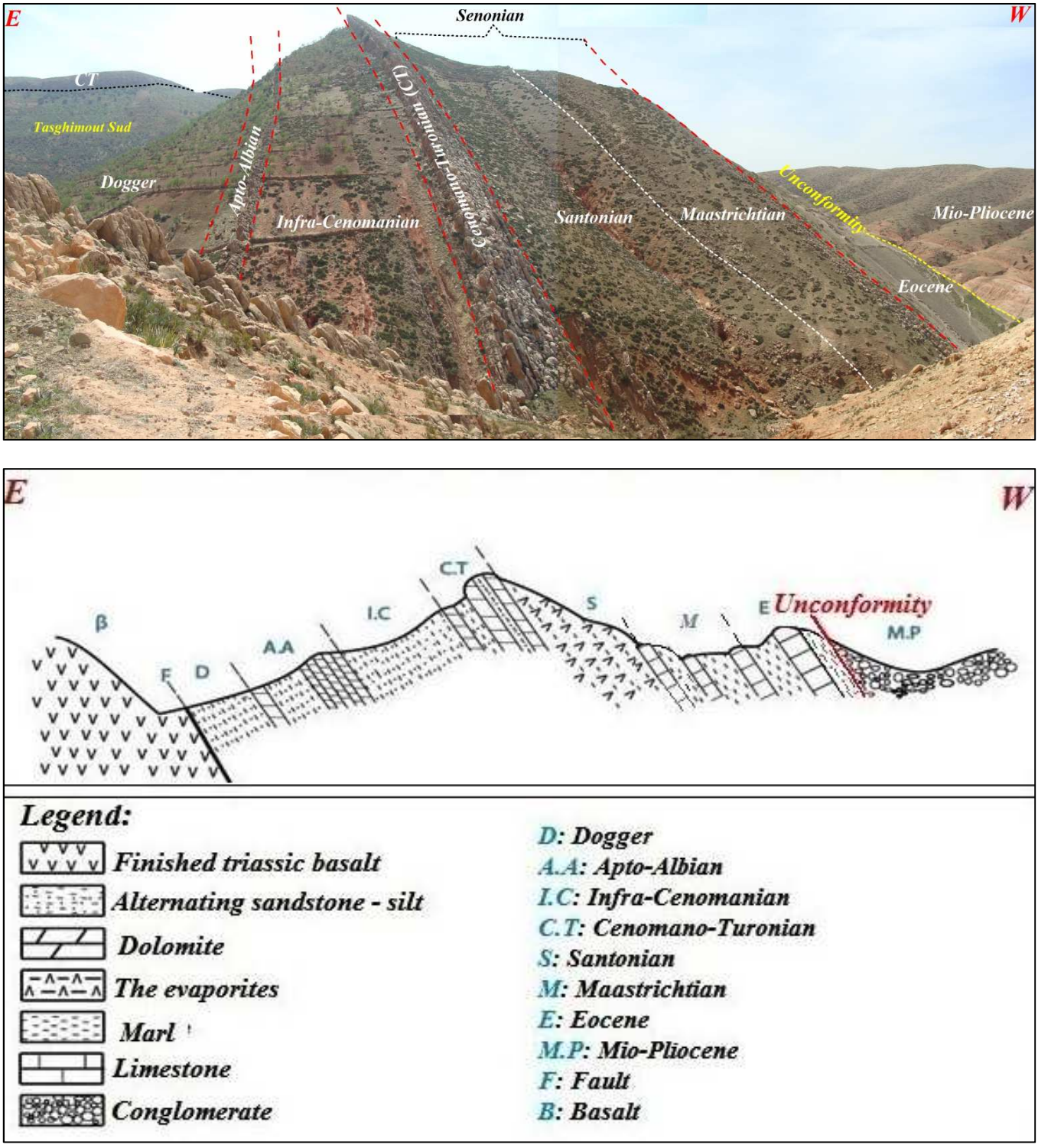


Fig.4 : Vue Panoramic view and geological section of the NW side

STUDY OF CLAY MINERALS

INTRODUCTION

In order to achieve data on the paleoenvironment a diffractometry study of clays (particle size of less than 2 µm) has been performed on various tests: natural state, saturation to ethylene- glycol, heating to 490°C hang two hours.The method pursued is the one designed by ***Holtzapel (1985)***

CRYSTALLINITY OF THE ILLITE

The parameter of crystallinity chosen is that of (***Kubler et al, 1979),*** which is the width at mid-hauteuir (above the background noise) of the Pic 001 illite to 10A°.

This crystallization is used to highlight the transformations related to diagenesis ***(Weaver 1960, Kubler 1968, Dunoyer de Segonzac, 1969)***

The fluctuations of illite crystallinity parameters in our region are limited in the low diagenesis area, which suggests a negligible influence, or even zero diagenesis of burying on the clay mineral. Furthermore, the study area does not show major tectonic index and the overlying deposits are little thick. All these characters argue in favor of a detrital origin of illites, from the erosion of the back country.

MINERALOGY AND CLAY PROCESSIONS

The clay assemblages constituting these units are homogeneous in all samples, they essentially show an association illite-smectite which is omnipresent in all cuts, with relatively high concentrations of illite (42% to 75%). This association is accompanied by other minerals that appear in different ways:

- Of regular interstratified (chlorite - smectite) have been rarely detected with a low percentage (25%). This level shows indications of an evaporite enviromnent;
- The chlorite which does not exceed 23% is always associated with the illite;
- Kaolinite which rarely appears and of a sporadic manner with always having the low concentrations (5 to 10%) ;
- Sepiolite was found in a silo-gypsiferous with a relatively low concentrations.

DISCUSSION AND INTERPRETATION

The illite and chlorite are of primary minerals, they generally come from the erosion areas emerged to accentuated relief. The Associations illite-chlorite, ill, smectite, found in our samples as well as the high percentage of primary minerals ite especially the illite, and the character of detrital sediments analyzed, suggest a mechanical erosion active of the continental bedrock under the effect of a morphological rejuvenation of the back country.

The kaolinite is essentially a detrital mineral, characteristic of superficial, acid environment, hot and humid climate and reflecting the proximity of shorelines ***(Dunoyer de Segonzac, 1969).*** However, it may have a diagenetic origin by neoformation.

In our sector, the low percentage of kaolinite and its association with primary minerals (illite, chlorite), suggests a rather detrital origin and thus reflects the proximity of reliefs relatively accents.

The sepiolite that is a magnesian fibrous clay represents the chemical pole of the clay sedimentation ***(Sauterau, 1973).*** Its formation, requires the presence of magnesium and silicon, in a basic enviromnent ***(Millot. 1964),*** to slice of low water, confined in an evaporitic context and under a warm dry climate. Its presence in gypsiferous levels of our sector argues in this sense.

GENERAL CONCLUSION

As a conclusion to all of these data, we propose a sedimentary rocks model under a restricted marine internal platform, of sebkha type whose boundaries are governed by the land surface, leading to an isolation of the environment, favoring water containment, under a warm and arid climate. This environment is intersected by marine incursions generating carbonate deposits to marine influences more important than the sediments underlying and subsequently suggesting slight transgressions, which quickly degenerate.

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