EXAMPLE OF PALEOSEBKHA LITTORAL DEPOSITS OF SENONIAN IN THE "BASINS ZONE" OF AIT OURIR (MARRAKECH HIGH ATLAS, MOROCCO)

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Abstract

The comparative analysis of three cuts oriented West-East at the level of the basin of Jbel Sour, led to defining during the Santonian:
A western sector of detrital coarse sediments, deposited in the context of a fluvial dynamics.
Oriental sector of mainly carbonato- evaporite sedimentation, in a less deep and confined environment, subject to significant subsidence under a hot, arid climate favoring the formation of sebkha facies.
These santonien deposits are organized in a regressive megasequence, surmounted by a Maastrichtian transgressive formation, corresponding, in this area, to a tidal-flats environment. This Maastrichtian serie marking the return of the epicontinental sea, under a hot, arid climate, by an Atlantic transgression encompassing the entire study area.

Keywords: Senonian, Sebkha, Sedimentation, Ichnofacies, Containment, Subsidence Marrakech High Atlas

Presentation

The basin of Jbel Sour is located about fifty kilometers SE of Marrakech, in the Touama region **(Fig .1)**. It belongs to the “basins zone" of Ait Ourir, which is itself attached to the sub "Northern subatlasique area" (Roch 1939).

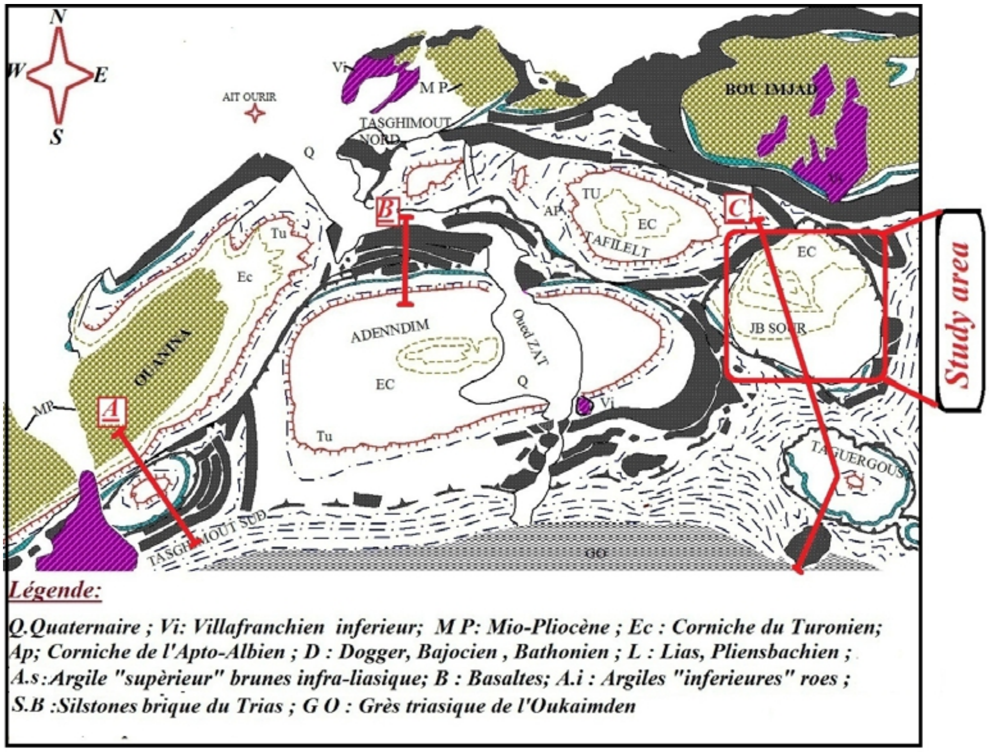


Fig.1 : Geological sketch map of Ait Ourir. (FERRANDINI J. And LE MARREC A., 1982).

These basins wear a Mesozoic post-Hercynian cover pleated in large flat-bottom and subhorizontal syncline, separated by ejective and acute anticlines (Ferrandini and Le Marrec 1982). These are allochthonous lands which slid during the main Atlas phase **(Fig 2).** This sliding was triggered by the movements of reverse faults responsible for the uplift of the Atlas system, and continued by gravity to the NNW.

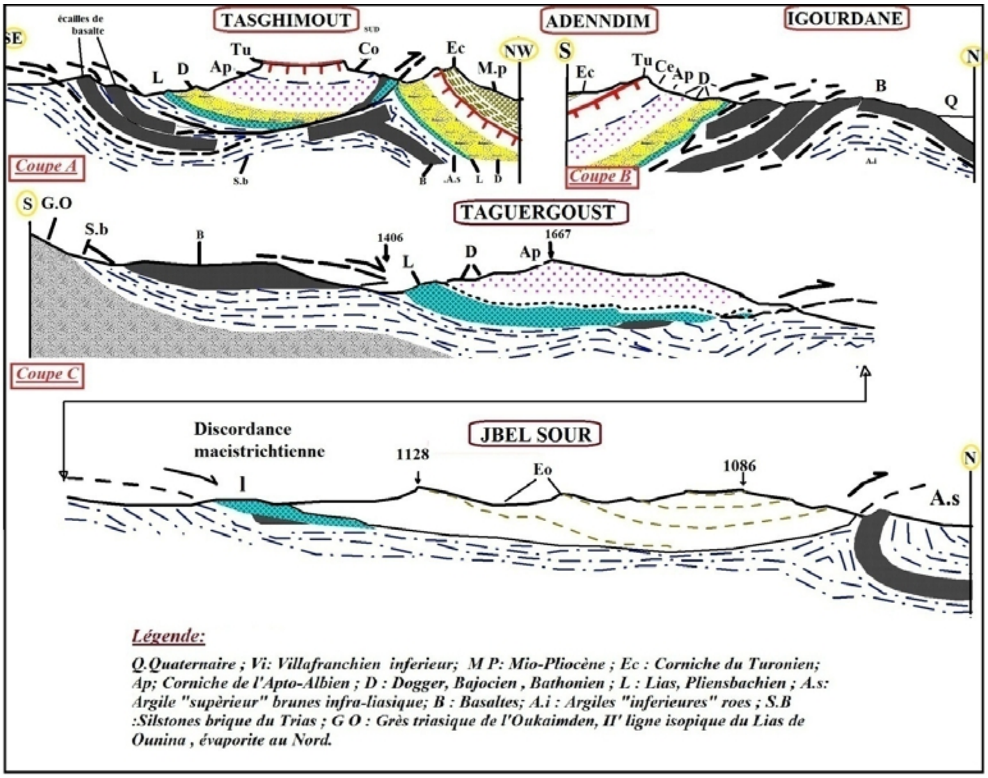


Fig 2: Profils of the " basins area" of Ait Ourir (FERRANDINI J. And LE MARREC A., 1982).

The objective of this study is the Senonian of the basin of Jbel Sour. Because lateral variations of facies and thicknesses, three West - East cuts were needed to address this study.

Each cut was subdivided into three units, and it's reflecting a clear mesosequence. The three units (U1, U2, U3) are attached to the Santonian (Algouti, 1991), by palynological dating and by analogy of facies with the western sector of Western High Atlas (Algouti and al.1998 and Algouti 1999).

Each unit is divided into two sub-unit, the first subunit reflects a transgressive interval (IT) and the second subunit reflects a high level of marine prism (PHN), additional the two sub-units are separated by a maximum flooding surface (SIM) (Fig.3).

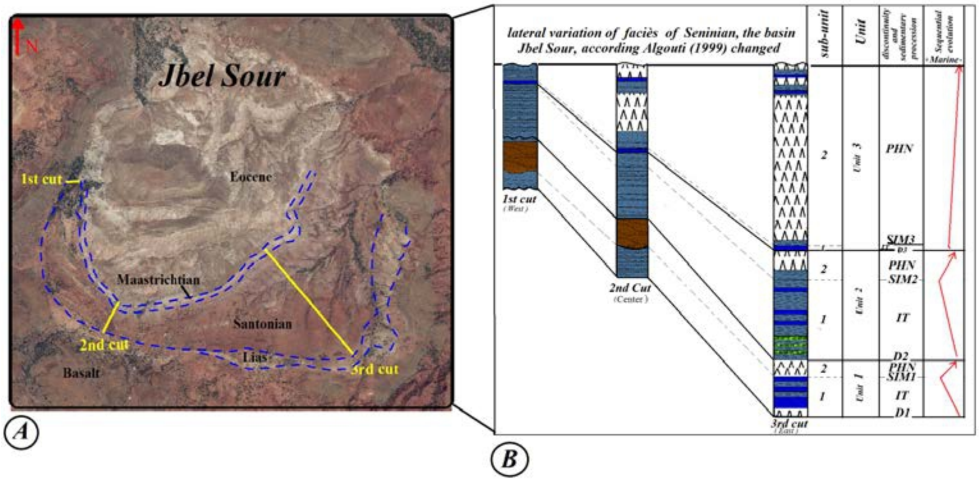


Fig. 3 : A: Geological map shows the location of three cuts.**B:** Lateral variation of facies of Senonian, the basin Jbel Sour, according Algouti (1999) changed.

This Senonian formation is very thin in the western sector (90m) and very thick in the eastern sector (366m). It is framed by the discontinuities D1 and D4. D1 is marked by a major angular unconformity with discordant Senonian on the rest of the cover **(Board 1 / Photo 1).** D4, on the other hand, is marked by a erosive base healed by coarse phosphatic levels marking a radical change of facies **(Board 1 / Photo 2).**

Unit 1

Sub-unit 1

It is formed at the base by a centimeter-level reshuffle breach topped mainly by silts that show in the West centimeter-levels microconglomeratic of fluvial origin affected by flood stages, generators of facies reshuffle. Traces of roots have been found in these silty levels; they are of cylindrical appearance and are branched. They are interpreted as witnesses to the presence of plants; they indicate a sedimentation stop and installation of plants.

Laterally eastward, these siltstones pass a series of small Gypso-silty sequences with past sandstone, reflecting supratidal marine environment. At the top, in the western part, we have sandstone deposits showing several sedimentary structures and figures namely: micro-channels, wavy laminations parallel, oblique, curved, intersecting, water exhaust figures **(Board 2 / Photo 1)** and Synsedimentary slip, lineations offense unidirectional current ripples, interference and vibration, "herring bones structures" **(Board 2 /Photo 2)** and soft rollers **(Board 2 / Photo 3**). This is associated with bioturbations of types: Skolithos, Diplocraterion and Thalassinoides **(Board 2 / Photo 4)** indicating a sandy bottom in a coastal

environment ranging from inferior to subtidal, energy conditions from moderate to relatively high (Seilacher, 1967, Frey and Pemberton, 1984). The general conclusion drawn from sedimentological and inchnological analyses is a marine sedimentation under tidal influence, subjected to high hydrodynamic regimes.
A statistical study of sedimentary figures measures (micro-channels, current ripples) showed a mean direction of paleocurrent to the SE. The explanation of the other distributions of the measures on the rose could be due to meandering structures of the channels.
This detrital set gives way to the far east to carbonato-silty clay deposits, characterizing a quiet environment, in a shallow intertidal to supratidal zone, affected by repeated exondations, in more or less confined conditions.

Sub- unit2

It is formed in the west sector by a succession of elementary conglomérato-sandstone-silty sequences translating the filling of stream channels. The angular shape of pebbles and the abundance of matrix reflect a weak transport and therefore highlight the proximity of nourishing source. These coarse deposits go east to silty gypsiferous levels reflecting a confinement in a supratidal environment concentrated with brines.

Unit 2

Sub-unit 1

It begins with an erosive base (D2) (in the West) that is usually topped by alternating sandstone and silt. These latter show indices of a paleosol under a portion of water relatively low as to allow the development of plants. The sandstone deposits resemble those seen in the sub-unit 1 of U1 and show traces of legs of birds at the base of a sandstone level . These sandstones come from a beach environment of marine sedimentation under tidal influence, subjected to high hydrodynamic regimes. Indeed, the particle size analysis performed at the levels of sandstone friables, revealed a mixed environment.

These detrital deposits end with a strongly bioturbation surface. They are surmounted to the East by a silty carbonate succession which took place in an inter-supratidal calm and confined environment. The carbonate deposits are best stored in the far east. They are centimeter, of mudstone texture, thin, lenticular and of platelets form. They show stromal structures and several figures emersion namely teepees, slots of desiccation, "birds-eyes", "sheet-cracks" and dissolution vacuoles. These vacuoles sometimes have gypsiferous relics, of small sticks form. They show a partial recrystallization at their periphery in granular calcite. Sometimes they are completely filled with granular quartz. The Silicification, in these levels, is highly developed, We find petaloid quartz, microcrystalline quartz, fibrous quartz, quartzine, chalcedony ...

In the eastern part, the sedimentation is thus carried out in a quiet, confined, environment unfavorable to organic life and in a evaporite context of sebkha type.

Sub-unit 2

It is very small and is formed by finer, silty sandstone-evaporite deposits with gypsiferous silts and azo and azo sandstone with casts of halite cubes, reflecting a decrease in detrital contribution and increased confinement under low water layer concentrated in brines associated with significant evaporation, usually in the context of a hot and arid climate.

Unit 3

Sub-unit 1

It begins on the east by a sandstone-carbonate bank with bioturbation of Skolithos type from east to a carbonate centimeter bank under the form of dolomitic limestone pads. This is a dolomitic biomicrite of wackestone type to ostracods and of dissolution vacuoles with sparite recrystallized periphery showing radiating chopsticks of anhydrite. These carbonate levels are bioturbated and show the presence of stromal structures. All these characteristics lead us to suggest an intertidal environment with low hydrodynamic energy, and in conditions of high brine concentrations. The presence of crystallized evaporites during the diagenesis and silicification argue for this. In addition, the sometimes radiating arrangement of calcitisée anhydrite is reminiscent of that described by Cussey (1979) for the anhydrite of carbonated sebkha.

Sub-unit 2

It consists of a very small evaporite sequence in the West where it is formed by a marl-term (9m) azo and very thick to the east where it is represented by evaporite Gypso-silty sandstone deposits. The gypsiferous banks are of saccharoïde type with different structures **(Board 3)** laminated structures, nodular structure of "Chichen wire" and "enterolithic structure" type. The presence of the latter in the gypsiferous banks characterize an evaporitic environment of sebkha type (Kinsmann1969 ; Scherman, 1979) These evaporites are related to evaporation phenomena in arid climate in Supratidal area at the level of capillary fringe of sediments (Cussey, 1979) These evaporite deposits therefore reflect an area of shallower bathymetry in a evaporitic environment of sebkha type related to evaporation phenomena in arid climate in Supratidal area at the level of the capillary fringe sediments. The manifestation of a subsidence **(Board 4)** , especially in the eastern margin of the basin, promotes the concentration of evaporates and the formation of a thick gypsiferous series

(216 m) in a confined environment, of sebkha type.

Conclusion

In a lateral (west to east) and vertical context, we note, is in this formation, decreasing particle size evolution with increasing confinement. The western region seems to have worked as a nearest area of a high relief, showing sediments largely influenced by detrital contributions in the context of a fluvial dynamics. The abundance of primary minerals (illite and chlorite) argues for this direction. The eastern region is subject to a particularly carbonato-evaporite sedimentation, in a favor of a less deep environment, subjected to confinement and periodic exondations under a hot, arid climate favoring the installation of sebkha facies affected by further subsidence. This evaporitic series continues with healed erosive base a phosphate microconglomerates limestone cement, granodécroissants, containing mussels of gastropods and bivalves. These are levels of phosphate Maastrichtian (Algouti et al. 1999).

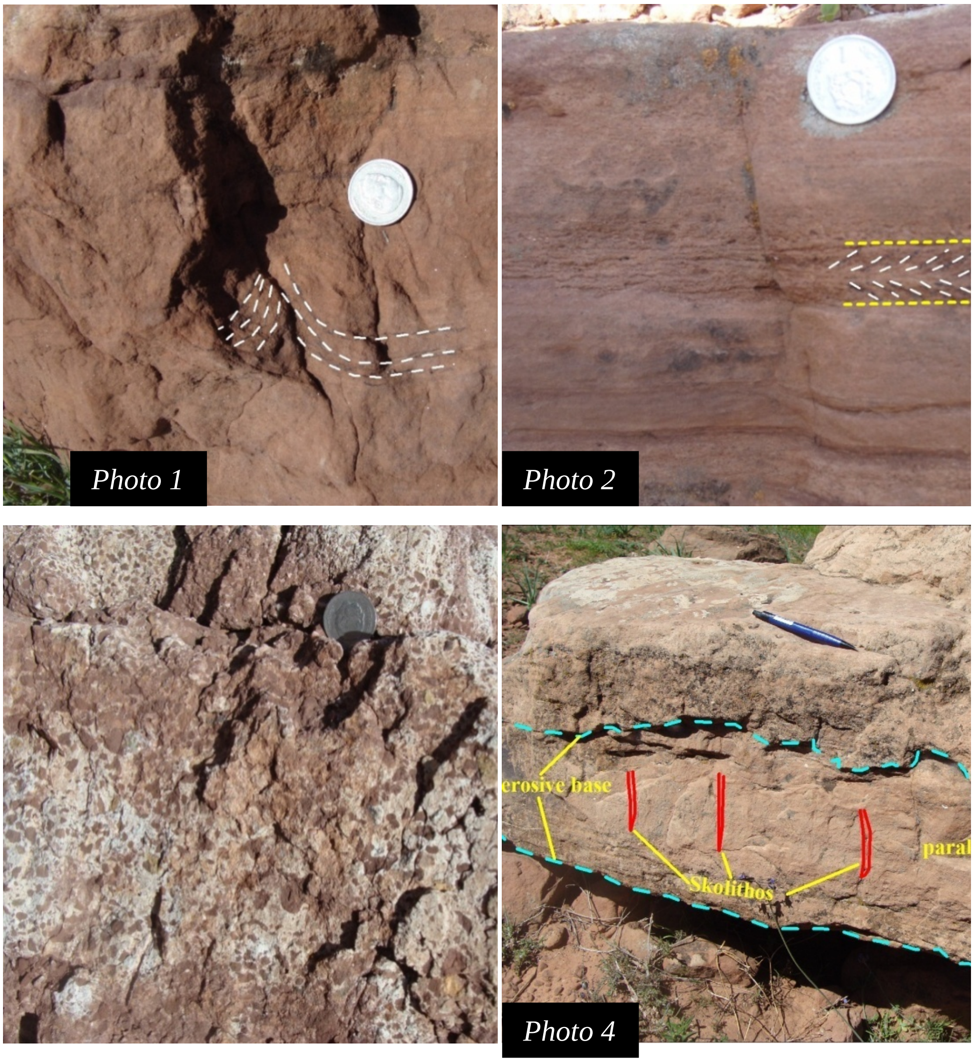
Board 1

<u>Photo 1</u>*: The red formation (Senonian) reposeful in angular unconformity on the rest of cover*

<u>Photo 2</u>: *Panoramic view taken at the Ighris village showing a red formation surmounted by a cornice Maastrichtian*

Board 2

Different sedimentary structures encountered at **(Unit 1 /Sub-unit 1) :**
Photo 1*:* Water exhaust figures.
Photo 2: Herring bones structures.
Photo 3*:* Soft rollers.
Photo 4*:* Skolithos type terriers.



Board 3

Different gypsum structures encountered in (**Unit 3** / **Sub-unit 2**)

<u>Photo 1</u>*: gypsum saccharoïde to nodular structure in the base, and enterolithic in the top.*

<u>Photo 2</u>*: Gypsum saccharoïde from laminar structure*

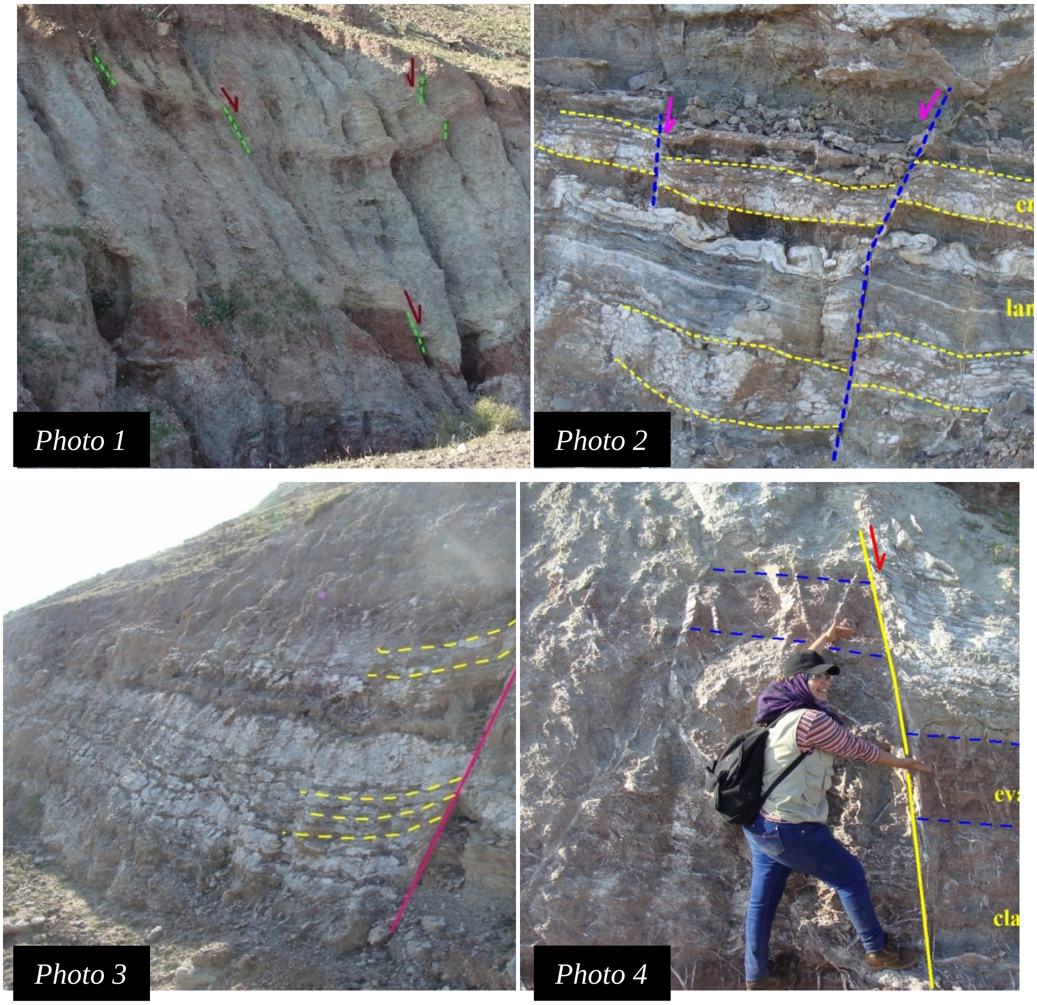
<u>Photo 3</u>*: Gypsum saccharoïde to enterolhitic structure*

<u>Photo 4</u>*:* Association: Gypsum nodular- Laminar gypsum- enterolithic gypsum and fibrous gypsum . (Type sabkha)

Board 4

Subsidence at the (**Unit 3** / **Sub-unit 2**) *level form:*

- grabens (*photo 1 et photo 2)*
- and normal faults *(photo 3 et photo 4)*



References:

ALGOUTI A. (1991). Turonien supérieur et sénonien de versant Nord du Haut Atlas de Marrakech : caractérisation sédimentlogique et stratigraphique .Thèse de 3éme cycle, Univ. Cadi Ayyad , Marrakecch. 250p

ALGOUTI A . (1999). Le Sénonien (CONIACIEN, SANTONIEN, CAMPANIEN , ET MAASTRICHTIEN) du Haut Atlas occidental (MAROC) : Sédimentologie, stratigraphie séquentielle, biostratigraphie et évolution géodynamique.Thèse d'état es-Science ,Fac. Sci. Semlalia, Marrakech

ALGOUTI Ah., ALGOUTI Ab. Et TAJ- EDDINE K . (1998) . Le Sénonien du versant Sud du Haut Atls Occidntal, Maroc : Sédimentologie et Analyse Séquentielle ; Biostratigraphie et Paléogéographie. Journal Of African Earth Sciences. 21.

CUSSEY R. (1979). Anhydrite diagénitique de sebkha carbonatée dans le Tertiaire d'Irak . In : ''Dépôts évaporitiques. Illustration et interprétation de quelques séquences''. Technip ed. Paris, pp.51-56.

FERRANDINI J. et LE MARREC A. (1982). La couverture jurassique est allochtone dans la « zone des cuvettes » d'Ait Ourir (Maroc).C.R.Acad. Sc .Paris ,t.295,série II.pp.813-816.

FREY R . W . and PEMBERTON S. G. (1984). Traces fosils. Facies Models .In: Walker R.G Facies Models, Second Edition .Geoscience Canada ,Reprint Series 1Mc Master University, Hamilton, pp.189-207.

KINSMAN D. J. J (1969). Model of formation , Sedimentary associations and diagnosticFeatures of Shallow water and supratidal evaporites. Bull. Amer . Ass . Petrol. Geol ,53, 4, pp. 830-840

ROCH E .(1939). Description géologique des montagnes à l'Est de Marrakech. Notes et Mém. Serv. géol. Maroc, 51, 438p.

SEILACHER A.(1967). Bathymetry of trace fossils . Marine Geology, V.5, pp. 413-428.

SHEARMAN D. J . (1979). Les faciès évaporitiques de Sebkha,in « Dépôt évaporitiques. Illustration de quelques séquences ». Technip ed.Paris, p, 19,6pl.