Journal of Geology & Geophysics
ISSN: 2381-8719
Ayed-Khaled et al., J Geol Geophys 2017, 6:6
DOI: 10.4172/2381-8719.1000310

Research Article

Open Access

Halocinese and Halotectonics in the Northern Atlas: Case Study of the Triassic Outcrop of J. El Matria (Oued Zarga Area)

Amira Ayed-Khaled[1]*, Mohamed Sadok Ben Salem[2], Ines Ezzine[1] and Mohamed Ghanmi[1]

[1]*Department of Earth Sciences, FST, Tunis El Manar University, Tunisia*
[2]*University of Sciences of Gabes, city Erriadh, Gabes, Tunisia*

Abstract

Apart from the Triassic salt bodies, there are several structural elements that characterize the Oued Zarga area. The new field data allowed us to deduce that the structural evolution of this region is essentially based on two generations of dextral strike-slip faults: an E-W direction to WNW-ESE and a later NW-SE second trend. In the study area, the Triassic material of J. El Matria is framed by two sedimentary contacts. Lower contact in clansayesian clays characterized by a glauconic to Triassic insoluble conglomerates and an upper contact where the Triassic material is covered by a thick pelagic series attributed to the lower Albian. This configuration results from a rapid lateral outpouring during the Lower Cretaceous in an extensive tectonic context and re-folded during the tertiary compressive phases, interpreted like most Triassic structures in northern Tunisia, in terms of the "salt glacier" with Lower Cretaceous age.

Keywords: Septentrional atlas; Structural; Triassic, Salt glacier, Sedimentary contact

Introduction

The geological history of Tunisian Atlassic chain is part of the structural and geodynamic evolution of the SE margin of the Maghrebian Tethys (Alpine chain) (Figure 1) and the northern extremity of the African mound [1,2]. During the convergence of plates between Africa and Eurasiatics, which ended with the Tethysian closure, the Tunisian margin was submitted to a compression constraint. This period characterized by 2 miocene effects have contributed to the deformation of the study area [3], which is part of the "salifereous province" [4] (Figure 2) and corresponds to the 1/50,000 map of Oued Zarga. Ghanmi [5] agree that this area corresponds to a deep furrow domain during the Lower Cretaceous, and is characterized by diapiric movements from the Aptian interpreted as "dome" or "diapirs". The nature and age of evaporite deposits have been widely studied and discussed in the Tunisian geological literature since the beginning of the previous century [6,7]. An idea of a Lower cretaceous age was developed by Bolze [6], based on the continuous upward passage of saliferous deposits at the lower Aptian. This proposition was subsequently disapproved by other geologists [8-10]. Recently Kamoun [11] confirmed the age of these outcrops by discovering a Triassic ammonoid. The development of a Triassic facies in outcrop has been studied seriously in Tunisia in the "diapiric zone" at which the Triassic deposits occupy a NE- SW alignment. The models previously presented show that the geometry and the mechanism of formation of Triassic structures in northern Tunisia are geological problems which raise serious challenges. Northern Tunisia, in which the Triassic intumescences are well manifested (Figure 2), presents a singular paleogeographic evolution controlled by the interaction between regional eustatic variations and local tectonic deformations. It is characterized by several extensional and shearing events associated to Triassic ascensions [12]. Three essential models have been proposed which have explained the rise and the setting of the Triassic material: the model of domes, inducing

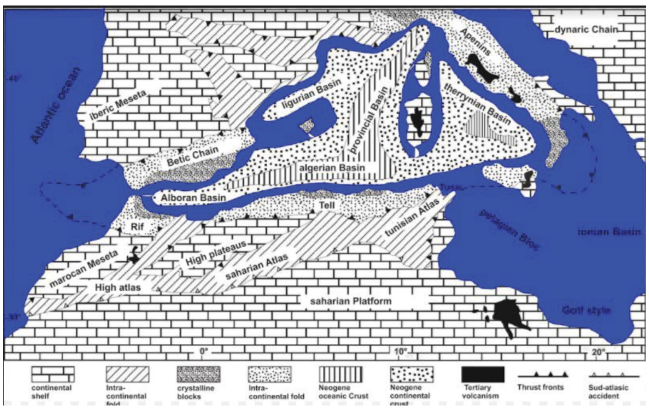

Figure 1: Tectonic model of the western Mediterranean domain.

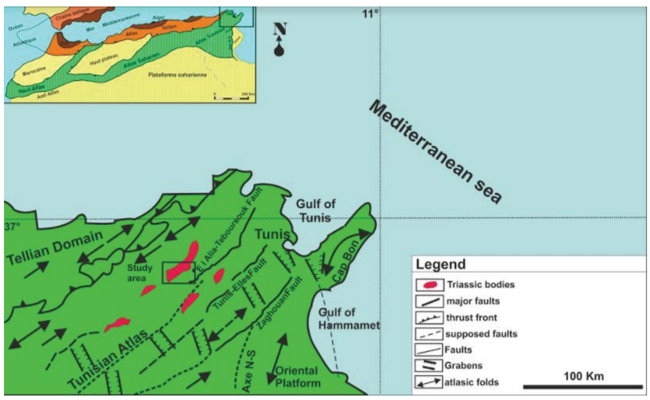

Figure 2: Geographical and geological location of the study area in the Mediterranean area.

***Corresponding author:** Amira Ayed-Khaled, Department of Earth Sciences, FST, Tunis El Manar University, Tunisia, Tel: +216 71 887 713; E-Mail: amiraayedgeology@gmail.com

Received October 06, 2016; **Accepted** October 26, 2017; **Published** November 03, 2017

Citation: Ayed-Khaled A, Ben Salem MS, Ezzine I, Ghanmi M (2017) Halocinese and Halotectonics in the Northern Atlas: Case Study of the Triassic Outcrop of J. El Matria (Oued Zarga Area). J Geol Geophys 6: 310. doi: 10.4172/2381-8719.1000310

Citation: Ayed-Khaled A, Ben Salem MS, Ezzine I, Ghanmi M (2017) Halocinese and Halotectonics in the Northern Atlas: Case Study of the Triassic Outcrop of J. El Matria (Oued Zarga Area). J Geol Geophys 6: 310. doi: 10.4172/2381-8719.1000310

"dome structures", from which the name of the "zone of the domes" [6,9], the diapiric model [4,13-15] and the "salt glacier" model proposed by Vila and Charrière [16], which imposes a new interpretation of the Triassic outcrops on the Algerian-Tunisian confines. This leads to a systematic review of Triassic outcrops in this area. Vila [12]; Ghanmi [4] highlight two zones separated by the "Téboursouk" accident (Figure 2), the northern one, the "salt glacier" zone and the southern one known as "real diapirs" [5,12,16]. The mechanism of these Triassic bodies is controlled essentially by a system of faults (Fig.2) from EW and NS to NE -SW directions [3,17]. These lineaments contribute to the deformation of the study area as well as the north of Tunisia. Thus, they are organized in conjugate fault systems reactivated during Miocene compressions. The aim of this work is to study and discuss the concept of the setting of Triassic material in the Oued Zarga region (J. El Matria area) (Northern Tunisian Atlas) in relation to the different generations of faults responsible for the structuring of our studied area, in order to apprehend, therefore, a model of structural and geodynamic evolution of the study region.

Geological Setting

Tectonic directions

The tectonic directions governing the geology of the study region have long been defined. These are essentially E- W, N-S and NE-SW. However, it can be pointed out that the meridian direction and the E-W direction are the two main directions which have shown an influence in the structuring of this zone during the different tectonic phases. The meridian direction is manifested in the first place by the outcrop of the Triassic material of this zone " Salifereous structure of Thibar", in fact one of the great saliferous structures of Tunisia. This structure takes a meridian direction. But this tectonic direction is manifested by NE-SW faulting, the most spectacular of which is the "Téboursouk" overlap that extends from El Alia to the Teboursouk region and continues towards the southwest (Figure 3) [9,18,19]. It constitutes "the eastern boundary of the zone systematically affected by tangential accidents of the type" bed load "[9]. The EW direction is marked by the Zeldou accident limits the Zeldou massif to the north (Figure 3), which reverts to the dextral strike-slip fault [14,15]. In the study area, the normal inherited faults were at the origin of the first Triassic salt extrusion with a N40-50 and N 110-120 direction which are at the origin of the tilted block layout during [20,21].

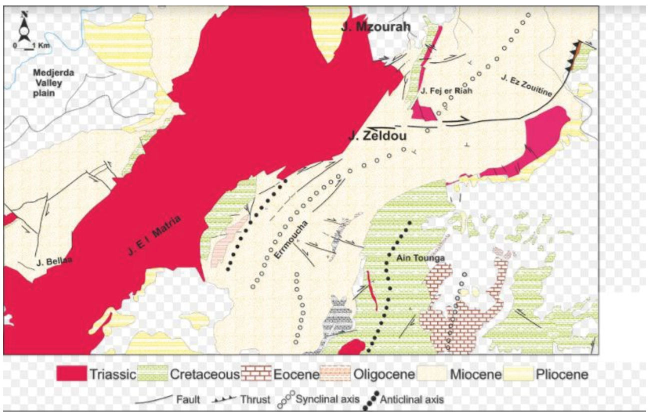

Figure 3: Structural map on the study region (Oued Zarga).

Position of triassic material

The sedimentary series that are outlined in the study area range from the Triassic to the Quaternary (Figure 4), and the Jurassic display no outcrops in the area. The stratigraphic study of these series is based on several lithostratigraphic sections. This study mainly concerns the Mesozoic and Cenozoic series, recording the different tectonic phases known in the region. In fact, these are essentially extensive Mesozoic phases and then compressive from the Tertiary to the present. The Triassic material outcrops occupy a very important surface (Figure 2) [18,22,23]. The Triassic rocks are composed of evaporites with thin layers of clay, sands, limestone, dolostones, detrital rocks, and minerals of neoformation. This material is marked by the existence of magmatic rocks (ophites) which are volcanic rocks associated to Triassic material and spreaded in the western part of our study area. Some authors describe it as a "Triassic complex" [14,24,]. Because of the chaotic organization and the lack of original stratification often explained by the ascension movements of Triassic masses and by the intervention of tectonic activity. During this period, 5 Tunisia is in the form of a shallow platform located between the African craton and Thetys in the NE [25]. Regionally, Laaridhi-Ouazza demonstrates basaltic emissions in the salt-producing mass of the study region (Thibar), showing at least during the Triassic period a distensive regime.

Stratigraphic Study

In the J. El Matria area (Oued Zarga, northern Tunisia) (Figures 5

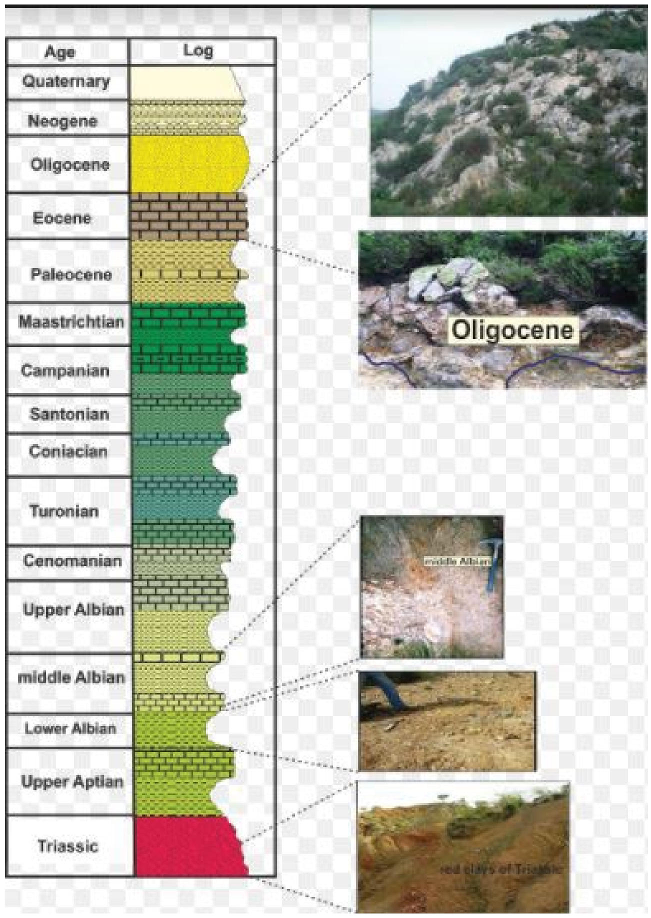

Figure 4: Geological map of the study area.

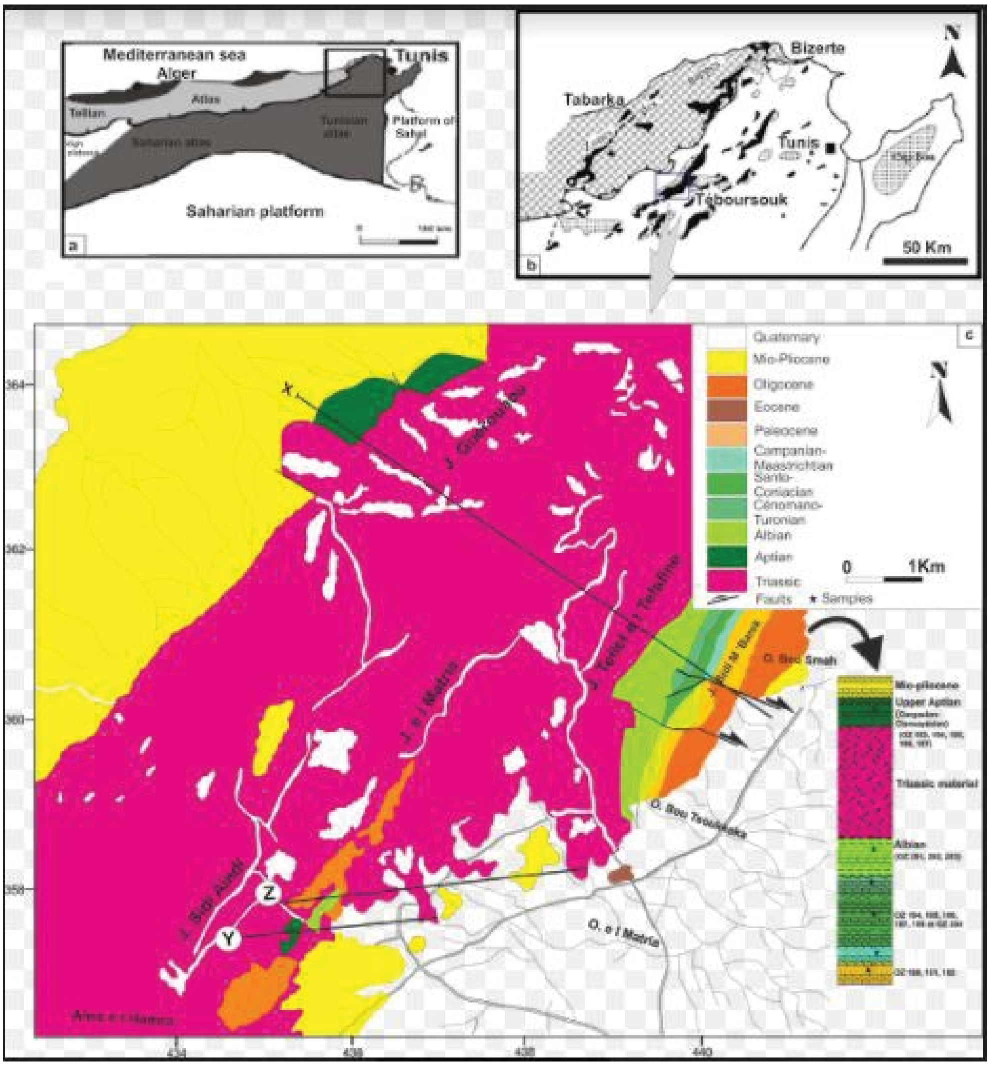

Figure 5: Synthetic stratigraphic log showing the different sedimentary series that outcrop in the study area.

and 6), below and above the Triassic material, we have been able to show two sedimentary contacts. The lowest contact is marked by glauconous conglomerates of Triassic insoluble matter; the lowest is characterized by similar conglomerates, which relate small lenses of reef limestones. To the north of Matria (Figure 6), under the lower contact appears a thick series of green marls and soft limestone with quartzitic intercalation (fine sandstone). These are deposits of unstable slope at the bottom of slopes. These marls deliver from Planomalina Chenourensis with often abundant microfauna of Lenticulines and Ticinelle. This association corresponds to the terminal Aptian (Gargasian-Clansayesian). On the upper contact (Figure 6) marked by discontinuous conglomerate levels lie gray marls with small pelagic or benthic foraminifera at Hedbergella roberti, Hedbergella trocoidea, a total association corresponding to the lower Albian. This series continues with a series of a few meters thick gray to blackish marls containing barite nodules and also deliver radiolaria of various shapes, Ticinella primula, Cytherella sp. (Many) attributed to the middle Albian. This series is surmounted by a bar of thick limestone (80 m) and formed by decametric and metrical calcareous beds, laminated, black alternate with laminated marls and limestones in platelets of gray or beige color containing ammonite prints and an epifauna Probable to a condensed level of belemnites. The upper Albian is dated in black marls by: Rotalipora appenninica, Rotalipora preticinensis, T. roberti, Lenticulina nodosa. The Albian series having a dip of 80° with the chaotic Triassic series, shows a clear concordant stratification. To the SE of the study area, Mio-Pliocene series formed of sand and red clay in discordance on the vertical Oligocene series on the one hand and on the other hand in discordance on the Triassic material. Towards the west, the Oligocene is discordant on the Paleocene clays having an inverse dip of 70° and plunging towards the SE with a ravining base and conglomerates reworked various elements of the previous series. At the J. Sidi Aiadi, the sandy Oligocene formed by deltaic deposits such as siliceous sandstones sedimentary features (sandstone nodules) is in discordance of 30° with the Lower Cretaceous series (Albian). This arrangement suggests a cretaceous axial part showing a near parallelism of the Triassic with its surrounding series. Our mapping shows that this device is affected by NW-SE dextral and late strike-slip faults. The presence of glauconic and conglomerate clays below and above saliferous material and his interstratification in the

Citation: Ayed-Khaled A, Ben Salem MS, Ezzine I, Ghanmi M (2017) Halocinese and Halotectonics in the Northern Atlas: Case Study of the Triassic Outcrop of J. El Matria (Oued Zarga Area). J Geol Geophys 6: 310. doi: 10.4172/2381-8719.1000310

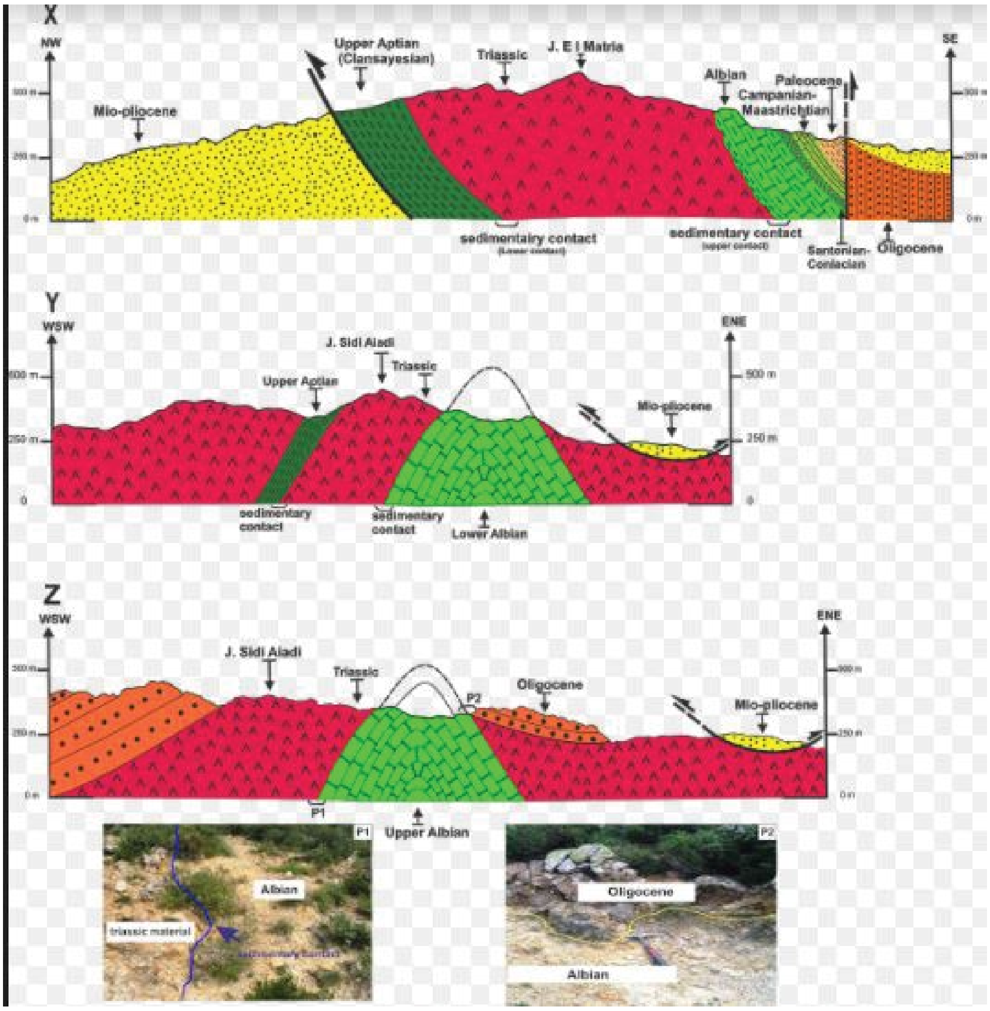

Figure 6: Geological sections at J. El Matria and J. Sidi Aiadi, located in Figure 5, showing the geometry contact of Triassic material with his surrounding series.

surrounding series demonstrate the sedimentary character of the two contacts: lower and upper of the "Triassic" material with the series of Lower Cretaceous.

Discussion and Conclusions

Geometry, nature of the contacts and new dating make it possible to observe and explain the interstratified character in the lower Cretaceous of the Triassic material of the "Diapir" of J. El Matria on the basis of the characteristics of the proposed positioning for most Triassic structures of the Algerian-Tunisian confines and Northern Atlas. These data confirm the hypothesis of interstratified Triassic material as previously reported in the field [26] and subsurface [27,28]. The Cretaceous series show “slumps” associated with arbonate nodules and packaged in the Lower Cretaceous marls. They are figures of a sedimentary instability of a margin in extension; this is in agreement with the majority of the work that has been done on this area. The discrepancies observed in the study area are those of the Oligocene and the Mio-Pliocene. In Sidi Aiadi area, the Oligocene is still discordant on underlying series. It is discordant at a low angle (20°) on the Lower Cretaceous which occupies the heart of an Atlassic anticline. The flattening of this Oligocene makes it possible to find an ante-Oligocene device weakly folded (20° to 25°), the verticalization of the oligocene series and the deposition of the mio-pliocene series in angular discordance in this area on the Triassic material, allows us to interpret the current structure from a tectonic inversion corresponding to the tertiary compressive event (the intra-Tortonian alpine phase), well known regionally and which allowed the Neogene to be deposited on the Triassic rocks. In addition, both regional and North African literatures confirm these observations [4,13,14,20,29]. These field data are included in the evolution of the margin of the North of Africa [25,30]. From the new elaborated map, two main generations of faults can be distinguished: The first generation is E-W to WNW-ESE, it is dextral strike- slip faults (Figure 7). The second generation is dextral NW-SE faults that affect all the more recent series. N-S accidents are still active to this day [25]. At the Oued Bou Smah area, located in the south of our study area, the presence of "slumps" that affect the Lower Cretaceous series, suggest the existence of a paleopente responsible for these deposits, remaining after the rapid outpouring of the saliferous material. This publication presents a detailed study of the J. El Matria region, based mainly on field data. The type of evolution that we propose is in opposition of purely compressive "classical" diapirist conceptions, which would be manifested in particular by a reversal of the substratum of the saliferous material when it is put in place. We have observed nothing of this kind in our study area, but on the contrary, a normal stratigraphic polarity of the floor of the saliferous material is demonstrated thus,

Figure 7: Field photographs showing the structural elements in the study area.

the presence of a source of fresh water in full Triassic rocks in Aïn Melliti area avoids the hypothesis of rooting Triassic material. These data show that, as in all neighboring regions, the halokinetic movement initiated in the Jurassic and continued in the Cretaceous. It controlled the distribution of sedimentation and the location of the associated structures during the deformations in extension. After a distensive period from the Aptian to the Turonian, this has favored the effusion of Triassic material, successive tertiary compressions fold and flake the interstratified Triassic blade. These changes of tectonic regime are faithfully recorded regionally in the magmatic activity which signs distension to the lower Senonian [31]. Regionally, the Triassic material of J. El Matria area seems to be interpretable from the tertiary folding of a submarine "salt glacier" included in the Upper Aptian with a scenario similar to those of the " Glaciers "of Kebbouche, Ben Gasseur and Fej el Adoum in the diapiric domain of northern Tunisia [4,5,29]. As well as other examples that include the submarine "salt glaciers" of the Golf Coast of Mexico and North America [32,33] and the salt glaciers of Northwestern Germany [34-36].

References

1. Dercourt J, Zonenshain LP, Ricou LE, Kazmin VG, Le Pichon X, et al. (1985) Presentation of nine 1/20,000 palaeogeographic maps extending from the Atlantic to the Pamir for the period from Lias to the Present. Bulletin of the Geological Society of France 8: 637–652.
2. Bouillin J P (1986) The Maghreb Basin, an old boundary between Europe and Africa in the Western Alps. Bulletin of the Geological Society of France 8: 547–558.
3. Rouvier H (1977) Geology of the far north of Tunisia. Tectonics and paleogeography superimposed on the eastern end of the North Maghrebi range. Annals of Mines and Geology pp.427.
4. Vila JM, Ghanmi M, Ben Youssef M, Jouirou M (2002) The passive salt " glaciers " of the northeastern Maghreb (Algeria-Tunisia) and Gulf Coast (USA) margins: Comparaisons, new look at the composite "salt glaciers", illustrated by that of Fedj el Adoum (North-West Tunisia) and global review. Eclogae Geologicae Switzerland 95:347–380.
5. Ghanmi M, Ben Youssef M, Jouirou M, Zargouni F, Vila JM, et al. (2001) Cretaceous halokinesis at Jebel Kebbouch (North-West Tunisia): establishment at water level and evolution of an albian "salt glacier", comparisons. Eclogae Geologicae Switzerland 94: 153–160.
6. Bolze J (1954b) Stratigraphic positions of salt formations in the diapir area in northern Tunisia. Academic Rendums of Sciences, Paris 258: 4594- 4596.
7. Burollet PF (1956) Contribution to the stratigraphic study of Central Tunisia. Annale of Mines and Geology pp.352.
8. Gottis C, Sainfeld P (1954) General comments on the Triassic of Tunisia. Accounts of the Summaries of the Geological Society of France 21: 262–266.
9. Jauzein A (1967) Contribution to the geological study of the borders of the Tunisian Dorsal (Northern Tunisia). Annals of Mines and Geology 22: 243– 433.
10. Biely A, Rakus M (1972) Critical analysis of data on the age of Salifera in northern Tunisia. Notes from the Geological Survey of Tunisia 38: 35–49.
11. Kammoun F, Peybernes B, Ciszak R, Calzada S (2001) Triassic palaeogeography of Tunisia. Palaeogeography, Palaeoclimatology, Palaeoecology 172: 223–242.
12. Vila JM, Ben Youssef M, Charrière A, Chikhaoui M, Ghanmi M, et al. (1994) Discovery in Tunisia at the SW of Kef triassic material interstratified in the Albian: Extension of the "salt glacier" domain under the sea of the Algerian-Tunisian borders. Academic Rendums of Sciences, Paris 318: 109–116.
13. Masrouhi A, Ghanmi M, Ben Youssef M, Vila JM, Zargouni F, et al. (2007) Demonstration of a two-unit Paleogene thrust sheet at the Lansarine Plateau (northern Tunisia): definition of a new structural element of the Tunisian Atlas and reassessment of the tertiary tightening schedule. Rendus Geoscience Accounts 339: 441–448.
14. Zargouni F (1977) Study of the ascensional movements of the triassic complex in the Lasarine range (Tunisian Atlas - "Diapirs" Zone). Notes from the Geological Survey of Tunisia 43: 13–21.
15. Boukadi N, Bedir M (1996) Halokinesis in Tunisia: Tectonic and chronological context of the events. Academic Rendums of Sciences, 322: 587–594.
16. Vila JM, Charriere A (1993) Discovery of Albian limestone and Triass resedimented at Jebel bou Jaber (western part, Algeria); Correlation with drilling and consequences on the organization of the Lower Cretaceous Algerian-Tunisian. Academic Rendums of Sciences, Paris 316: 785–790.
17. Kadri A, Ben Haj Ali M (1999) Elements of reflection on East-West and North-ud

tectonic lineaments and associated grabens in northern Tunisia. Notes from the Geological Survey of Tunisia 65: 131–140.

18. Ayed-Khaled A, Ghanmi M, Zargouni F (2012) Filtering of the gravimetric anomalies to the study of the geological structures of Oued Zarga (Septentrional tunisia): Structural implications. AJG 5: 169–180.
19. Ayed-Khaled A, Zouaghi T, Atawa M, Ghanmi, M (2015) New evidence on the geologic setting of Medjerda Valley plain (Northern Tunisia) from integrated geophysical study of Triassic evaporite bodies. Annals of geophysics 58: S0326.
20. Chikhaoui M, Maamouria AL, Salaj J, Turki MM, Saadi J, et al. (1998) Tilted blocks during the early Cretaceous in the Le Kef area (North- western Tunisia). Academic Rendums of Sciences, Paris 327: 265–270.
21. Ladeb MF, Horrenberger JC, Cailleux Y, Zargouni F (1995) Mesoscopic structures associated with distension in Central Tunisia (Dj Semmama). Academic Rendums of Sciences 321: 333–338.
22. Bajanik S, Salaj J (1970) New data on the scar zone of Oued Zarga region (northern Tunisia). Notes from the Geological Survey of Tunisia 32: 3–20.
23. Ben Salem MS, Ghanmi M, Zargouni F (2009) Modelling genesis of intracratonic chains related to tectonics inheritance. Case study from Gafsa basin (Southern Central Tunisia). JGG 1: 58–70.
24. Caire A (1977) Unitary tectonic interpretation of the Tunisian Atlas with ditches. Academic Rendums of Sciences, Paris 284: 349–352.
25. Bouaziz S, Barrier E, Soussi M, Turki MM, Zouari H, et al. (2002) Tectonic evolution of the northern African margin in Tunisia from paleostress data and sedimentary record. Tectonophysics 357: 227–253.
26. Ben Chelbi M, Melki F, Zargouni F (2006) Method of setting up salt bodies in the Northern Atlas of Tunisia. Example of the apparatus of Bir Afou. Rendus Geoscience Accounts 338: 349–358.
27. Vially R, Letouzey J, Benard F, Haddadi N, Desforges G, et al. (1994) Basin inversion along the North-African margin the Saharan Atlas (Algeria). Peritethyan Platforms, Paris, 79–118.
28. Bédir M. Zitouni L. Boukadi N, Saadi J, Alouani R, et al. (2000) Rifting, halocinese and structuration of the Jurassic and Lower Cretaceous sub-tethysian peri-tethyan basins of the central atlas region of Tunisia (region of Gafsa-Sidi Ali Ben Aoun). Africa Geoscience Review 7: 289–306.
29. Vila JM, Ben Youssef M, Bouhlel S, Ghanmi M, Kassaa S, et al. (1998) Raft tectonics at the Albian submarine salt glacier roof, in northwestern Tunisia: Gueurn Halfaya mining area example. Academic Rendums of Sciences, Paris 327: 563–570.
30. Bracène R, Frizon de Lamotte D (2002) The origin of intraplate deformation in the Atlas system of western and central Algeria: from Jurassic rifting to Cenozoic–Quaternary inversion. Tectonophysics 357: 207–226.
31. Laaridhi- Ouazaa N (2000) The magmatism of the Triassic of Tunisia: A tectonomagmatic approach. Annals of Mines and Geology 40: 5–9.
32. Diegel EA, Schuster DC, Shoup RC, Touvers PR (1995) Cenozoic structural evolution and tectonostratigraphic framwork of the northern Gulf Coast continental margin. In: Jackson, M.P.A., Robrts, D.G., Snelson, S. (Eds.), Salt Tectonics, a Global Perspective. American Association of Petroleum Geologists Memoir 65: 109–115.
33. Steven J, John W (2006) A new conceptual model for Scotian Margin Salt detachment on the Northeast Scotian margin, offshore Eastern Canada. American Association of Petroleum Geologists 90: 1407–1423.
34. Mohr M, Warren JK, Kukla PA, Urai JL, Irmen A (2007) Subsurface seismic record of salt glaciers in an extensional intracontinental setting (Late Triassic of northwestern Germany). Geology 35: 963–966.
35. Bajanik S, Salaj J (1985) The geological map of Oued Zarga. National Office of Mines, publication of the National Geological Survey of Tunisia, Sheet 26.
36. Doglioni C, Harabaglia P, Merlini S, Mongelli F, Peccerillo A, et al. (1999) Orogens and slabs vs. their direction of subduction. Earth- Science Reviews 45: 167-208.
37. Melki F, Zouaghi T, Ben Chelbi M, Bédir M, Zargouni F, et al. (2010) Tectono-sedimentary events and geodynamic evolution of the Mesozoic and Cenozoic basins of the Alpine Margin, Gulf of Tunis, North-Eastern Tunisia offshore. Comptes Rendus Geoscience 342: 741–753.
38. V, Bouzenoune A, Hatira N, Henry B, Laatar E, et al. (1999) The diapirs of the Eastern Maghreb: Part of the alpine deformations and the initial Cretaceous and Eocene structures in the current forms. Bulletin of the Geological Society of France 170: 57–65.