SEDIMENTATION AND FACIES ANALYSIS OF VOLCANICLASTIC UNIT WITHIN MAQDADIA FORMATION,INJANA AREA, SOUTHERN HEMRIN, NE IRAQ

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ABSTRACT:-

Field observations revealed the occurrence of volcaniclstic units (pyroclastic units) within the Muqdadyia Formation (Pliocene) in Injana area, southern Hemrin anticline; these rock-units located along Tayawi, Magrin and Zarloukh sections and has been called as a volcaniclastic unit of Muqdadyia Formation.

the facies analysis for the volcaniclastic units is part of succession which was deposited in a fluvio-laucustrine environment. This succession is divided into eight facies on the basis of deposition and transportion settings into:- 1-Primary tuff rock (non-reworking), this represent the surge facies (A_1) and fallout facies (A_2) which deposited in a quiet environment (lake or marsh) near Zarloukh area; 2-Secondary tuff rock these represent the sandy tuffstone (B_1), mudy tuffstone (B_2) and clayey tuffstone (B_3) which deposited in meander active channel environment during high concentration supply. And tuffaceous sand (C_1), tuffaceous mudstone (C_2) and tuffaceous claystone (C_3) which were deposited in the same environment but during low concentration volcaniclasts supply. Accordingly, the rock unit deposited by two stages of the supplying in volcaniclasts during three deposition cycles.

Key words:Maqdadia Formation,Volcaniclastic,Injana,Facies.

رسوبية و تحليل سحنات وحدة الفتاة البركاني في تكوين المقدادية، منطقة انجانة، حمرين الجنوبي، شمال شرق العراق

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الخلاصة

تبين من خلال الوصف الصخري لعدة مقاطع صخرية من تكوين المقدادية (بليوسين) والموزعة على مواقع(طياوي والمكرين وزرلوخ) عند منطقة انجانة ضمن طية حمرين الجنوبية ، إن هناك وحدة صخرية مكونة من الفتات البركاني المترسب مباشرة من الهواء بعد حدوث نشاط بركاني تسمى وحدة الفتات البركاني لتكوين المقدادية.

لقد اظهر التحليل السحني لهذه الصخور إنها تمثل تعاقب طباقي لبيئة نهرية – بحيرية من خلال تمييز ثمان سحنات صخرية ، والتي أمكن تقسيمها حسب ظروف النقل والترسيب إلى :- ١-صخور التوف الابتدائية (غير معادة الترسيب) والمتمثلة بسحنة الفتات البركاني المتمّور (A_1) وسحنة الفتات البركاني المتساقط(A_2)

وكلاهما ترسبا بثلاث دورات في بيئة هادئة قرب منطقة زرلوخ. ٢-صخور توف ثانوية (معادة الترسيب) والمتمثلة بسحنة التوف الرملي و التوف الطموي و التوف الطيني والتي تشير إلى الترسيب من الحمولة العالية في بيئة نهرية ظفائرية؛ وسحنة الرمل التوفي و الطمى التوفي والطين التوفي التي تشير إلى الترسيب من الحمولة الواطئة في نفس البيئة مع حصول عملية غسل بواسطة مياه الامطار او الفيضانات. لذا فان وحدة الفتات البركاني لتكوين المقدادية ممكن أن تكون قد ترسبت من تمّور وتساقط الرماد البركاني القادم من المنطقة الشرقية أو الشمالية الشرقية أو كلاهما وخلال مرحلتين من التجهيز بالرماد البركاني (العالي والواطئ) ولثلاث دورات ترسيبية تمثل كل دورة تجهيز عالي وواطئ على التوالي.

Introduction

The northerneast of Iraq affords many opportunities to investigate a wide variety of fluvial basins, and from these one basin associated with the narrow-spread Quaternary volcanoes was chosen for study. The Muqdadyia Formation, in which the so-called Al-Muqdadyia volcano-clastic unit of Pleistocene age , will be described here.

Geologic information is presented in several parts of which the present contribution gives the regional stratigraphy, data on the sedimentary structures, and discussions on the inferred depositional environment, all of which will be serve as a foundation for the future publications.

A few brief references were described the volcaniclastic unit as Bentonite sediments (1, 2, 3) in [1], [2], [3]. Therefore the present study will be very important to illustrate type of the sedimentary rocks.

The Volcaniclastic term was defined by Fisher (1961)[4] to refers to all clastic sediments and rocks, regardless of depositional process, whose particles are predominantly of volcanic origin, whereas the facies analysis of volcaniclastic sequences is in its infancy compared with other branches of sedimentology. Until very recently, little was known of lateral and vertical facies variations: - i.e. none of the currently available volcanology texts describes rocks sequences in any detail.

The interaction between volcanism and sedimentation; and development of concurrent facies are governed largely by two factors. These are :- 1- Active volcanism produces abundant sediment which are rapidly delivered to the sites of deposition, and 2- lateral changes which are the result of flow transformations. During eruptions. Large volumes of pyroclastic sediments are released far more rapidly than any process of production of epiclastic particles [5], [6], [7], [8], [9].

The present study will discuss the unique sedimentary facies to determine the sedimentation settings upon the bases these are suggested by [10] ,[11],[12] and [13]. While the normal sedimentary facies (fluvial succession) will be discussed upon the classified fluvio-lacustrine facies that suggested by [15].

Regional geologic setting

The studied area is situated to the NE extremity of the Arabian platform, in the Hemrin-Makhul subzone within unstable shelf of Iraq (Foot Hill zone) [16] in Hemrin area. The Muqdadyia Formation (Pleistocene) is one of formations exposed in this area on the two sides of Southern Hemrin anticline and parallel to the anticline axis **(Figure-.1).**

The Muqdadyia formation was deposited in fluvial environment in a rapidly subsiding foredeep basin by the meandering rivers. Therefore, the sediments of this formation characteristic by fining upwards cycles of gravely sandstone, sandstone and red mudstone The sandstones are often strongly cross-bedded and associated with channel lags and clay balls [16].

This paper deals with the study of the vol caniclastic unit in the Muqdadyia formation of four geological sections in three locations (Magarin, Tayawi and Zarloukh), which represent the lower part of this formation as a sequences alternate from the tuffstone, rocky tuff and tuffaceous rocks. The distribution of the volcaniclastic unit showing increase thickness from 50cm in Tayawi (T_1, T_2) to 2-5m in Magarin (M_1, M_2) and 8m in Zarloukh (Z_1, Z_2) **(Figure-.1).**

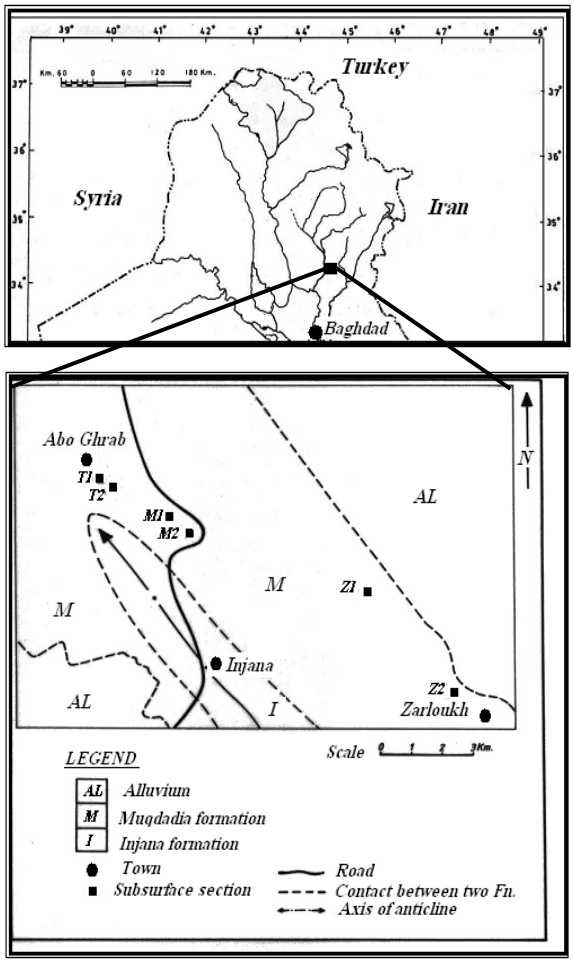


Figure-1: Location and geological maps of the studied area.

Lihthologic variation of volcaniclastic unit

The type of volcaniclastic rocks in the present study were defined by [17] as (unique sedimentary facies); this sediments was generated by exceptional processes. Therefore, the base of classification of volcaniclastic rocks will be different from the normal sedimentary rocks. The sedimentological study for the volcaniclastic units were according to framework of the volcaniclasts, the degree of mixed for the grains and/or grain-size variation, and from these bases we can be divided it into two main facies **(Table-.1)**

1-Non-reworking sediments (tuffstone facies) represents primary sedimentation from the eruption cloud.

2-Reworking sediments (rocky tuffstone & tuffaceous rock), represents secondary sedimentation from suspension load and\or bed load.

The lithological sections study are shown in (Figure -2).

(Table-1) Shows the subdivisions of the main facieses for the Maqdadia volcaniclastic unit.

Lithofacies	Sublithofacies
A-Primary Pyroclastic Facies (Tuffstone)	A1- Coarse Grained Tuffstone A2- Fine Grained Tuffstone
B-secondary Pyroclastic Facies (Reworked sediments)	B1-Sandy Tuffstone B2-MudyTuffstone B3-Clayey Tuffstone
	C1-Tuffaceous Sandstone C2- Tuffaceous Mudstone C3- Tuffaceous Claystone

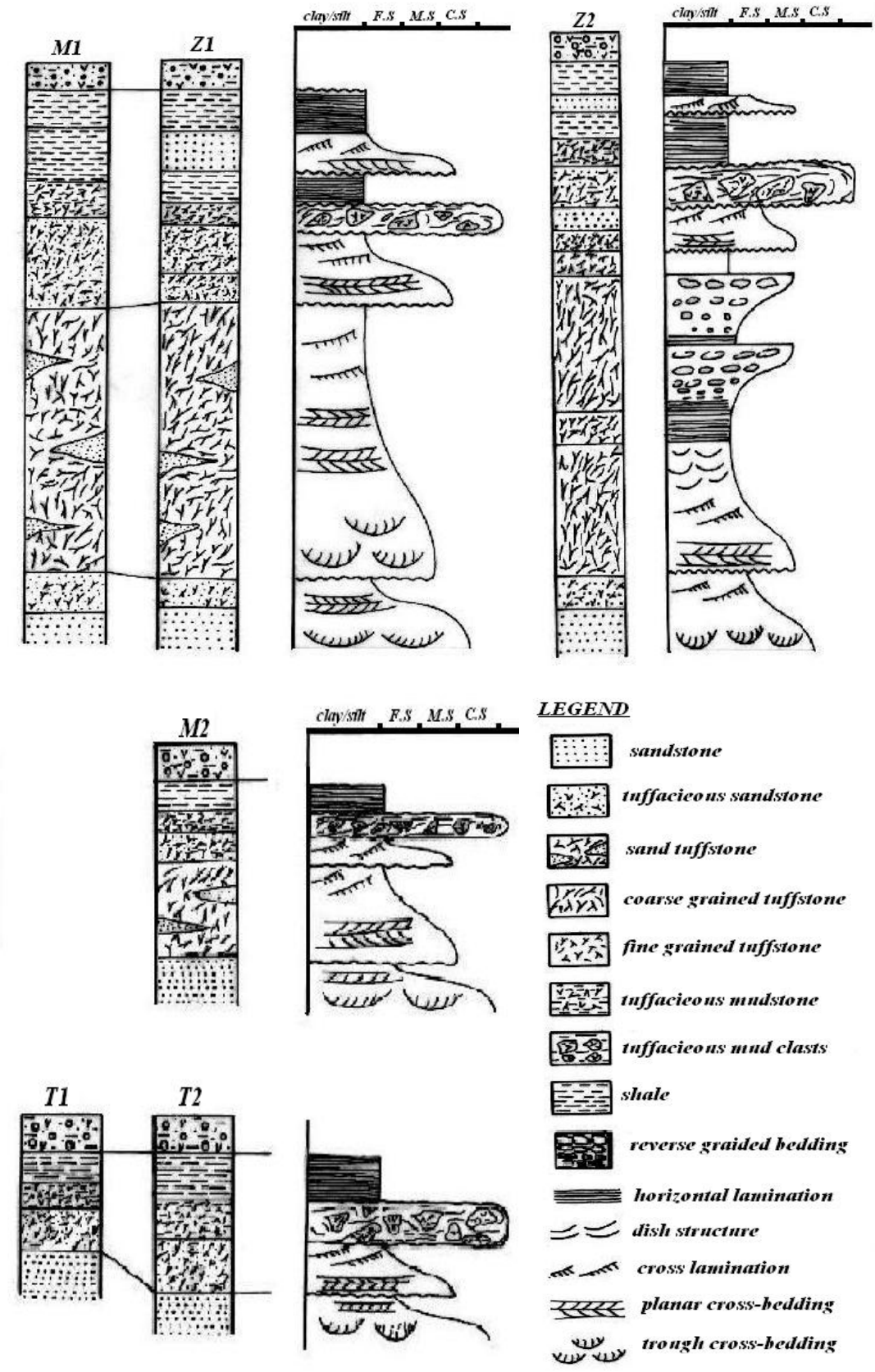
(Table-1) illustrates the subdivisions of the main facies for volcaniclastic unit of Muqdadyia formation depending on field description for the unit beds, petrography and sedimentology features

Lithofacies(A) :- This litho-facies rock [non-reworking sediments (tuffstone facies)] is uncommon distribution in the volcaniclastic unit of Muqdadyia formation. The general compositions for litho-facies (A) are glass shards (vitric 85%) and pyroginic minerals (15%). The lithofacies (A) may be divided into two sublitho-facies:-

1-Coarse-grained tuffstone(surge sublitho-facies)(A_1)
2-Fine-grained tuffstone(fall-out sublitho-facies) (A_2)

This lithofacies is of volcanic origin for sedimentary volcaniclastic rocks (unique sedimentary facies) [17], because it was deposited by exceptional processes and without any direct effects by the reworking processes

The sedimentary characteristics of these sublitho-facies (A_1, A_2) are described in (Table-2)



Figuer-2:Lithologic section of the studied areas, Zarloukh [Z_1,Z_2] ; Margin [M_1,M_2] & Tayawi [T_1,T_2] .

Litho-facies(B):-

The litho-facies(B) represents reworking sediments (rocky tuffstone & tuffaceous rocks) and composed of glass shards (vitric 65% & pyroginic minerals less than 10%) in sandy, mudy & claye tuffstone ; while the restricted ratio for detrital clasts (sand, silt, clay) those were deposited in the same time. According to the compositions of this litho-facies may be divided into three sublitho-facies:-

1- Sandy tuffstone(B_1)
2- mudy tuffstone (B_2)
3- claye tuffstone (B_3)

The litho-facies (B) represents normal sedimentary facies (fluvial succession) deposited during high supply volcaniclasts period. The accurate sedimentary properties for these sublitho-facies (B_1, B_2, B_3) are described in (Table-3)

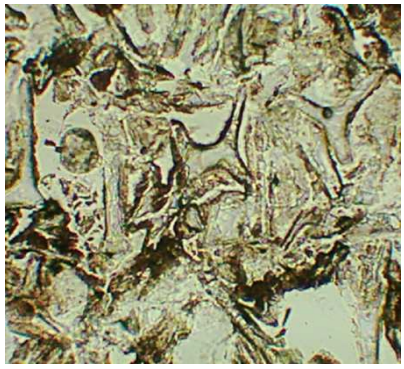
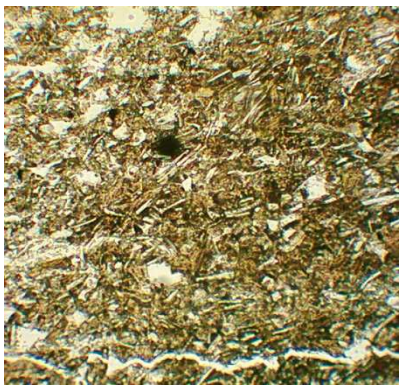
Litho-facies(C) :-

this litho-facies represents reworking sediments (tuffaceous rocks), its occurrence as rocks cover for this unit. The litho-facies (C) composed from detrital clasts (more than 85%) and pyroginic material (vitric & pyroginic minerals less than 15%). According to the compositions of this litho-facies may be divided into three sublitho-facies

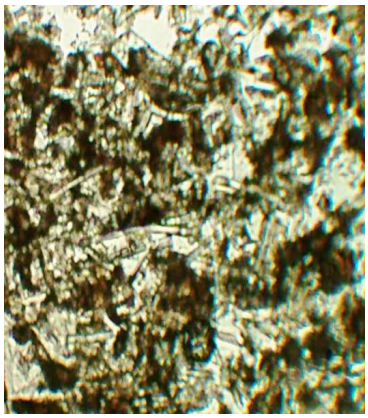
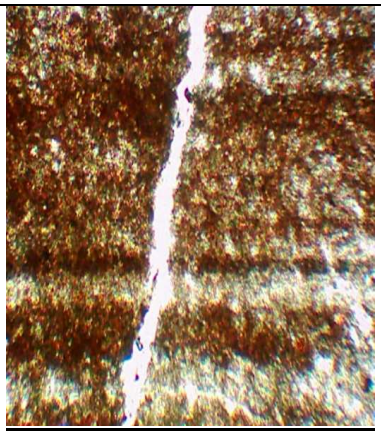
1-tuffaceous sandstone(C_1)
2-tuffaceous mudstone(C_1)
3-tuffaceous claystone(C_1)

The litho - facies (C) is represented normal sedimentary facies (fluvial succession). The accurate sedimentary properties for these sublitho - facies (C_1, C_2, C_3) are described in (Table -4)

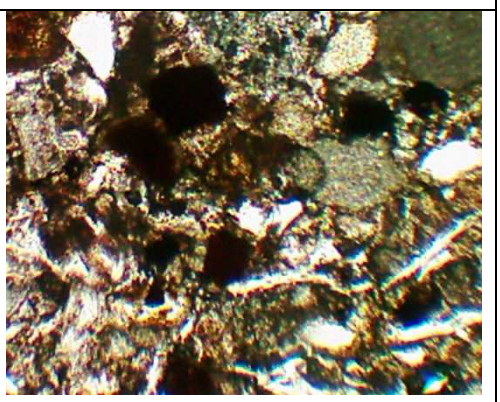
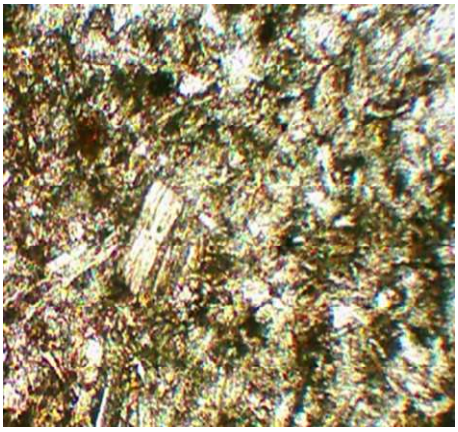
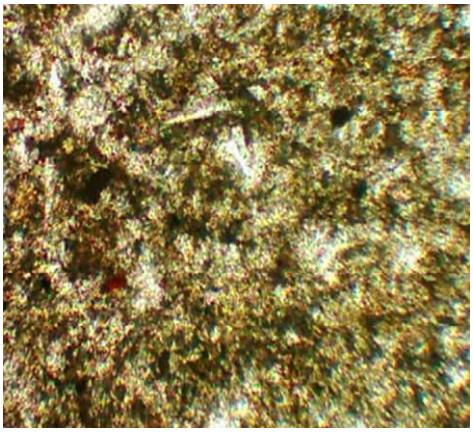
(Table-2) illustrates the description for the A_1 , A_2 sub-lithofacies and their interpretation.

sub-lithofacies	Field Description	interpretation	Petrographic shows
Coarse-grained tuffstone **(surge sublitho-facies)(A_1)**	Massive coarse grained rock, Well sorted sediments, characterised by reverse graded-bedding, dish structuer in upper part and lamination in lower part.	This sub-lithofacies indicates deposition from a highly concentrated air current (surge mechanical transportation).	
Fine-grained tuffstone **(fall out sublitho-facies) (A_2)**	Massive very fine grained rock, concoidal fractures, very well sorted sediments, characterized by reverse graded-bedding and lamination	This sub-lithofacies indicates deposition from a highly concentrated calm suspension air(fall-out mechanical transportation).	

(Table -3) The description for the B1 , B2 , B3 sub-lithofacies and their interpretation

sub-lithofacies	description	interpretation	Petrographic shows
Sandy tuffstone (B_1)	Brittle very coarse grained tuffs, poorly sorted sediments, characterised by chanal structure, tabular cross-bedding and contains mud-clasts in lower part.	This sub-lithofacies suggests rapid deposition from a highly concentrated current in high flow regime environment (active channel).	
mudy tuffstone (B_2)	Massive coarse grained tuffs, moderate sorted sediments, characterised by ripple mark , cross-lamination, reverse graded-bedding for vitric & normal for lithic and contined fine mud-clasts.	This sub-lithofacies suggests rapid deposition from a highly concentrated current in abandoned channel, that may be weathered and deposited in channel active as mud-clasts.	
clayey tuffstone (B_3)	Massive coarse grained rock, very well sorted sediments, characterised by lamination structures and reverse grading-bedded for vitric.	This sub-lithofacies may be rapid deposition from a highly concentrated current in abandoned channel alternative with B2.	

(Table-4) Illustrates the description for the C1 , C2 , C3 sub-lithofacies and their interpretation.

sub-lithofacies	description	interpretation	Petrographic shows
Tuffaceous sandstone **(C_1)**	Brittle coarse grained sand, poorly sorted sediments, characterized by channel structure, tabular cross-bedding and ripple marks in upper part.	This sub-lithofacies is indicative of deposition from a low-concentration in high flow regime environment(active channel) .	
Tuffaceous mudstone **(C_2)**	Massive fine grained clasts, poorly sorted sediments, characterized by laminations, mud-clasts and ripple marks in lower part.	This sub-lithofacies suggests rapid deposition from a low-concentrated current in abandoned channel; that may be weathered and deposited in channel active as mud-clasts.	
Tuffaceous claystone (C_3)	Massive very fine grained clasts, concoidal fractures, moderately sorted sediments, laminations and cross-lamination structures.	This sub-lithofacies may represent rapid deposition from a low-concentrated current in abandoned channel alternates with C2.	

Discussion and Conclusion:-

According to the above mentioned geological data and in a comparison with the characteristic of the pyroclastic facies (vertical succession) and alluvial facies (horizontal succession) (see Table- 2,3,4); a model can be suggested for the depositional setting and paleo-environment of these volcaniclastic unit in Muqdadyia formation.

This model is assumed the presence of two depositional stages of this unit rock.

Stage -1-

This stage represents the deposition from a highly concentrated air suspension loads during volcanic activities. In general, the pyroclasts (volcaniclasts) are transported far away from its source by two mechanisms : 1- calm suspension beds, and 2- turbulence suspension beds. These are generated as stratify beds and commonly show a systematic lateral decrease in grain size and bed thickness downwind[17]. Therefore the volcaniclasts of Muqdadyia formation could be transported from the east and northeast Iraq, and deposited along the east and northeast boundary of Iraq.

The pyroclastic grains (volcaniclasts) were deposited in alluvial environment as a fluvio - lacustrine succession. This succession represents two main litho-facies:- litho-facies (A) (non-reworking pyroclastic litho-facies) and litho-facies (B) (reworking pyroclastic litho-facies).

The litho-facies (A) represents a quite environmental properties, such as Zarloukh section (**Figure-.3**); which conserved the air transporting properties and that refers to the eruption period of the volcanic activities. There are three cycles of deposition for the successions A_1, A_2 as an alternation of coarse and fine clasts, which indicats the occurrence of three eruption periods in source area, while facies (B) indicates the deposition in channel active environment. These facies are clear in Maqarin and Tayawi sections **(Figure-3)** In this succession (B_1,B_2,B_3) the occurrence of other types of clasts (epiclasts and normal sediments for Muqdadyia formation) as result of reworking processes, forming the B1, B2 and B3 lithofacies

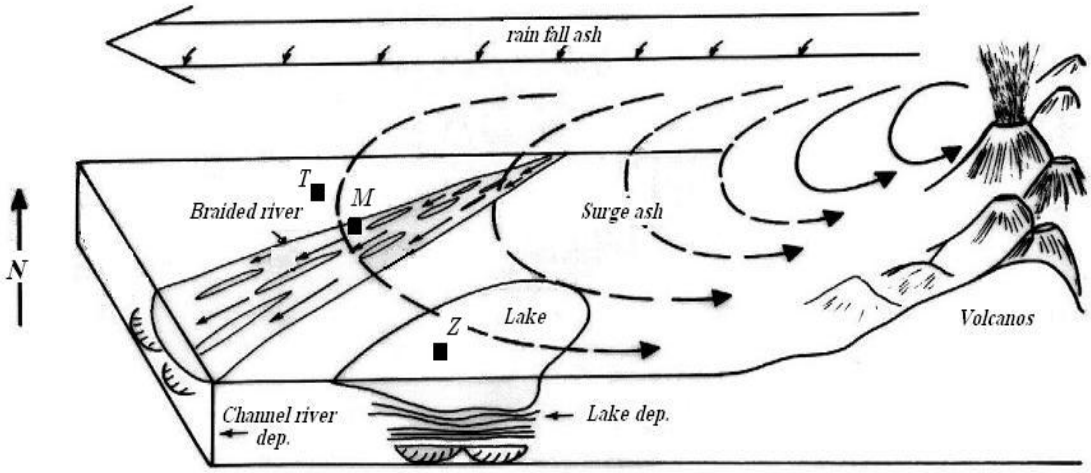


Figure-3: Sketch illustrating the first stage for deposition volcaniclastic unit in Muqdadyia Formation.

Stage -2-

This stage started by the decreasing in supplies of the pyroclasts (fall-out and surge volcaniclasts), which may be resulted from :- 1- decrease in the volcanic eruption and/or 2- the wind energy decrease. In addition to the environment changes from alluvial to lacustrine environment during deposition of volcaniclastic unit in study area (Zarloukh, Magarin and Tayawi) **(Figure-.4)**.These changes in depositional environment reflect the occurrence of a lacustrine succession [tuffaceous sandstone, mudstone and claystone (C_1,C_2,C_3)]. The tuffaceous sandstones are represented by thin lenses with mud-clasts and clay lamination. The volcaniclastic sediments deposited on land and reworked by washing by fall and flooding water to returned to the lacustrine & river water .

(Figure-5) shows the main facies and their distribution for the studied succession

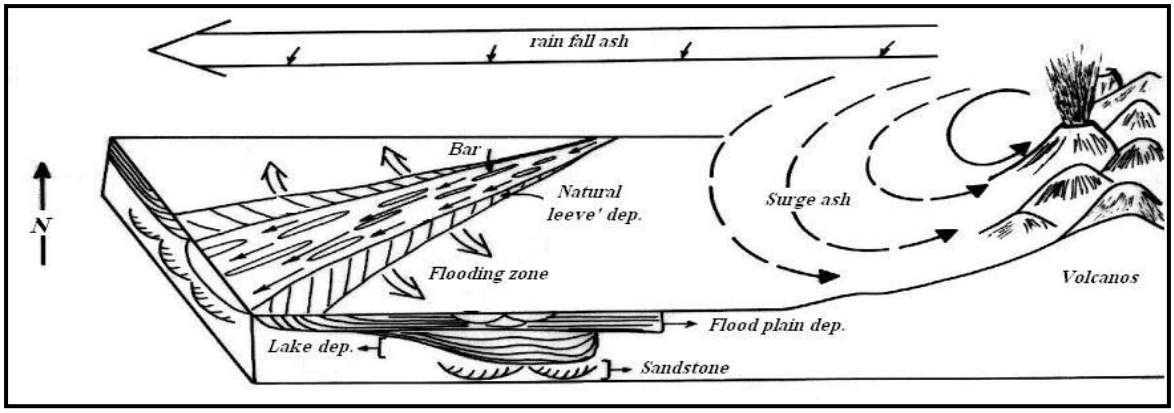


Figure-4: Sketch illustration the second stage for deposition volcaniclastic unit in Muqdadyia Formation

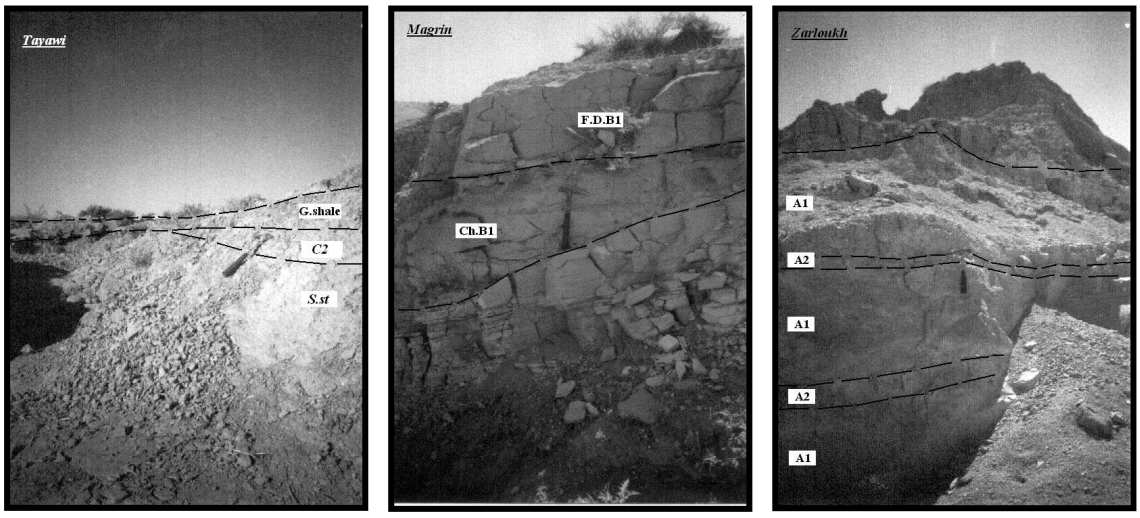


Figure-5: Photograph pictures for studied area illustration the main facies and their distribution .

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