Basin Development of the Red Bed Series, Ne Iraq.

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Abstract

The Red Bed succession of northern Iraq was developed in an active margin basin during the Paleocene-Eocene where the final closing of the Neo-Tethys and collision between the northeast Arabian plate with the Eurasian plate took place .This has caused major uplifts and subsidence episodes together with fluctuation of base level due to eustatic rises and falls. This variation throughout the Paleocene and Eocene produced a variability of settings ranging from proximal alluvial fan to braided river system, to distal meandering rives systems.
Keywords: Basin development Red Bed, NE IRAQ

الخلاصة

تطور تتابع الصخور الحمراء في شمال العراق ضمن حوض يقع على الحافة الشمالية الشرقية للصفيحة العرابية حيث المراحل الأخيرة من انغلاق بحر التثس الجديد وتصادم الصفيحة الأوروبية–الأسيوية خلال فترة (Paleocene-Eocene) الباليوسين–الايوسين.نتيجة لذلك تكونت مناطق رئيسية مرتفعة وفترات من التجلس بالإضافة إلى تذبذب مستوى سطح البحر العالمي مما أدى إلى تكون مختلف الأوضاع الترسيبية التي تشمل من المراوح النهرية إلى أنظمة الأنهار الضفائرية وصولا إلى أنظمة الأنهار الملتوية في الإطراف.
الكلمات المفتاحية : تطور الطبقات الحمراء.

Introduction

Basin analysis involves making an interpretation of the development, evolution, architecture and fill of a sedimentary basin by examining geological variables associated with the basin. The geological variables include all branches of geology. However, in the present study, the emphasis is put on traditional and sequence stratigraphy, lithology, sedimentary structures, facies association and fossil contents of the depostional area. All these are inspected in the field and lab for deduction of the environment, paleocurrent direction, and basin fill architecture and tectonic of the basin in addition to the correlation and subdivision of the rock body of the formation. Basin analysis provides a foundation for transferring known information into unknown regions in order to predict the nature of the basin where evidence is not available. This can assist the exploration and development of energy, mineral and other resources that may occur within sedimentary basins. This study deals with two different types of sedimentary rocks, which are clastics and carbonates. Detailed description is made for four exposed sections in Northern Iraq. (Fig. 1).

Samples are collected from the exposed sections in Sulaimaniya and Erbil Governorates (Fig. 1). In Sulaimaniya area two exposed section were studied, the first at southwest of Chwarta (E 45° 31′ 46.4″ and N 35° 42′ 23.1″ , E 45° 33′ 51.4″ and N 35° 45′ 6.3″). The second section is located near the Khewata village northwest (E 45° 26′ 25.9″ and N 35° 48′ 45.2″ , E 45° 27′ 24.9″ and N 35° 49′ 36.6″). (Fig. 1).

In Erbil Governorate, two exposed sections were to the southeast and northeast of Mergasure town. The first section of the Red Bed is exposed northeast mergasure along Mergasure - Zibar road (E 44° 15′ 58.5″ and N 36° 52′ 55.4″ , E 44° 16′ 48.5″ and N 36° 53′ 20.1″), the second section is located near Lailuk village southeast Mergasure town (E 44° 20′ 8.8″ and N 36° 49′ 43.8″ , E 44° 20′ 16.7″ and N 36° 50′ 22.8″) (Fig. 1).

Detailed petrographic study for 154 clastic samples was carried out (point counting). Also on 86 carbonate thin sections for the carbonates, intervals are made where microfacies analysis is aimed at paleoenvironmental interpretation. Identification of some fossils is carried out to identify these carbonate units. Sequence stratigraphic subdivisions are followed to understand the sequence development.

Purpose of Study

The main aim of the study is to investigate the development of the Red Bed succession of North Iraq, as follows:

1- Development of the depositional setting.

2- Sequence stratigraphic analysis to clear the effect of local tectonism and eustasy on development of the succession.

3- To understand the tectonic framework of sedimentation.

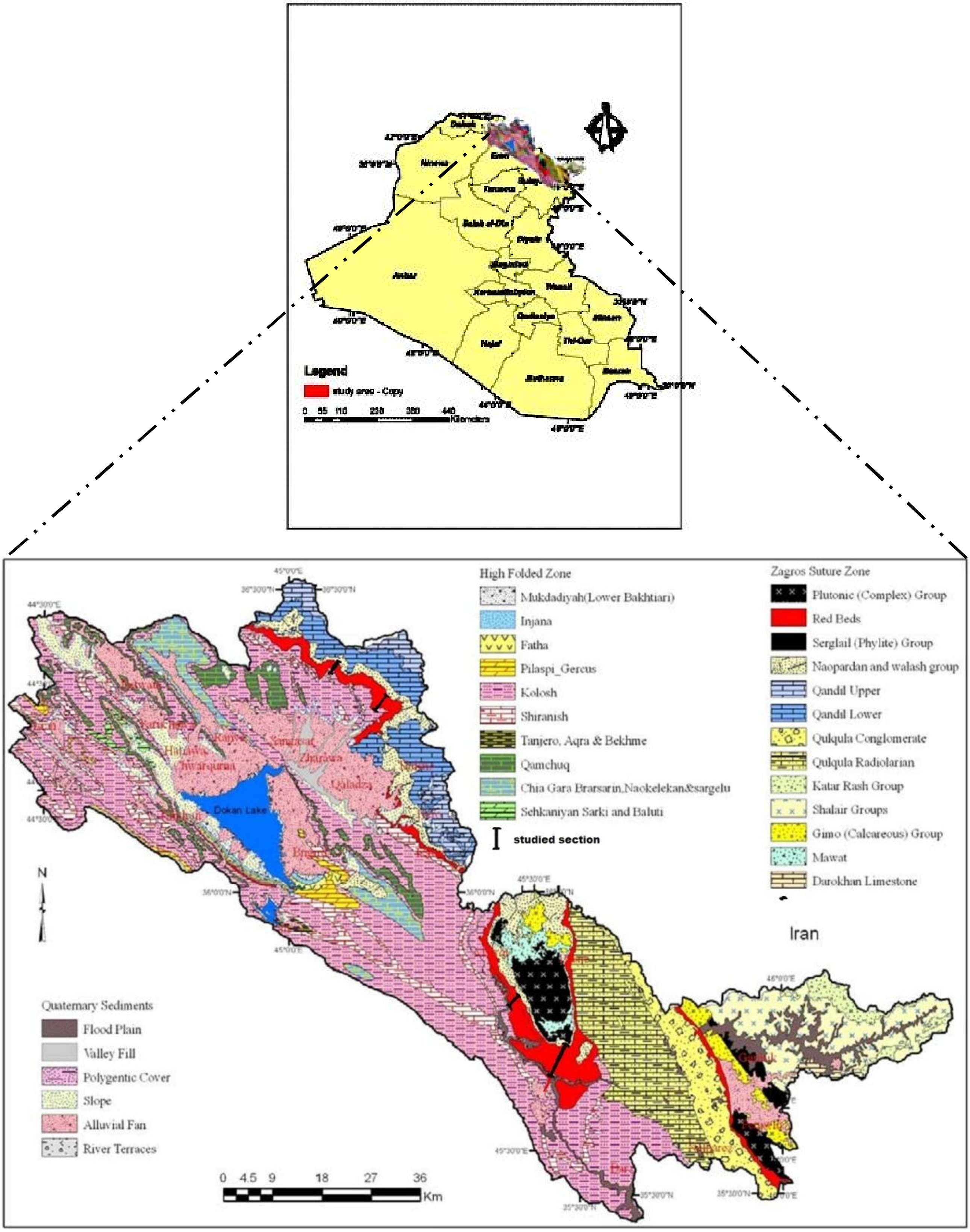

Fig. 1: Location and Geological map of study area. (after Ma'ala, 2008).

Tectonic setting

The studied area is located south of the Zagros Thrust Belt, which is developed due to the basin fill of the Neo-Tethys and collision of the Iranian and Arabian plates. Structurally the study area is located within the Imbricate Zone (Buday, 1980).

The Mawat- Chwarta area was considered as part of the eugeosynclinal zone (Buday and Jassim, 1987). The Red Beds were deposited in a narrow intermountain basin between the uplifted area in the northeast and a ridge located along the northeast side of Balambo-Tanjero zone running from Amadiya in the northwest through Ranya, Sulaimaniya and Halobja in the southeast (Jassim and Goff, 2006) (Fig. 2). The depositional system was greatly influenced by different types of tectonic features, which include regional and local tectonic activities. The local tectonic movement represented by syndepositional tectonic movement (contemporaneous tectonism), is closely related to the tectonic development of the faulted blocks and reactivation of pre-existing faults through compressional tectonic movement and had a strong influence on palaeogeography and depositional environments. Compressional tectonic movement is a characteristic feature of the Paleogene Emergence of the Arabian-African craton occurred due to an up doming phase prior to the rifting of the Red sea. This has caused a distinct change in the clastic-carbonate ratio. The denudation of the distally evolved land mass increased the supply of clastic sediments to the depositional basins (Drukman *et al.,* 1995).

Previous studies

The first definition and division of the Red Bed series was made by Bolton, (1958), who divided the succession into four units.

Al-Mehaidi (1975), divided the series into the lower Red Bed unit consisting of interbeded red and gray silty shale and claystone, radiolarian chert and gray detrital limestone. The sandstone unit consiss of lithic arenite fragments of igneous and metamorphic rocks. The conglomerate unit consists of poorly sorted conglomerate; the size ranges from pebble to boulder and consists of igneous and metamorphic rocks. The upper Red Bed unit consist of gray red and greenish calcareous lithic arenite, silt shale marly polymitic conglomerate and thin beds of limestone.

Karim (1975) studied the series paleontologically and suggested tits age is Miocene. Al-Ameri *et al.,* 1990), studied the palynology of unit one of Suwais Red Bed in Chwarta area, they concluded that this unit was deposited during the Santonian. Al-Barzinjy (2005) divided the Red Beds into six units, from bottom to top:-

1-Lower fine red clastic unit: consists of red claystone and siltstone with interbeds of sandstone and rare lenses of conglomerate.

2- Lower conglomerate unit, the clasts consist of pebble to boulder with some blocks. The white matrix consists mainly of coarse sandstone.

3-Sandstone unit consisting of alternation of thick succession of coarse and gray sandstone.

4-Middle coarse and fine clastic unit contains red claystone, sandstone and conglomerate.

5-Upper conglomerate consists of thick succession of conglomerate, which consists of type of clasts such as limestone, chert, igneous, and metamorphic rock fragments.

6-Upper fine clastics composed of calcareous shale, brown claystone, marl and sandstone with some couglomerate.

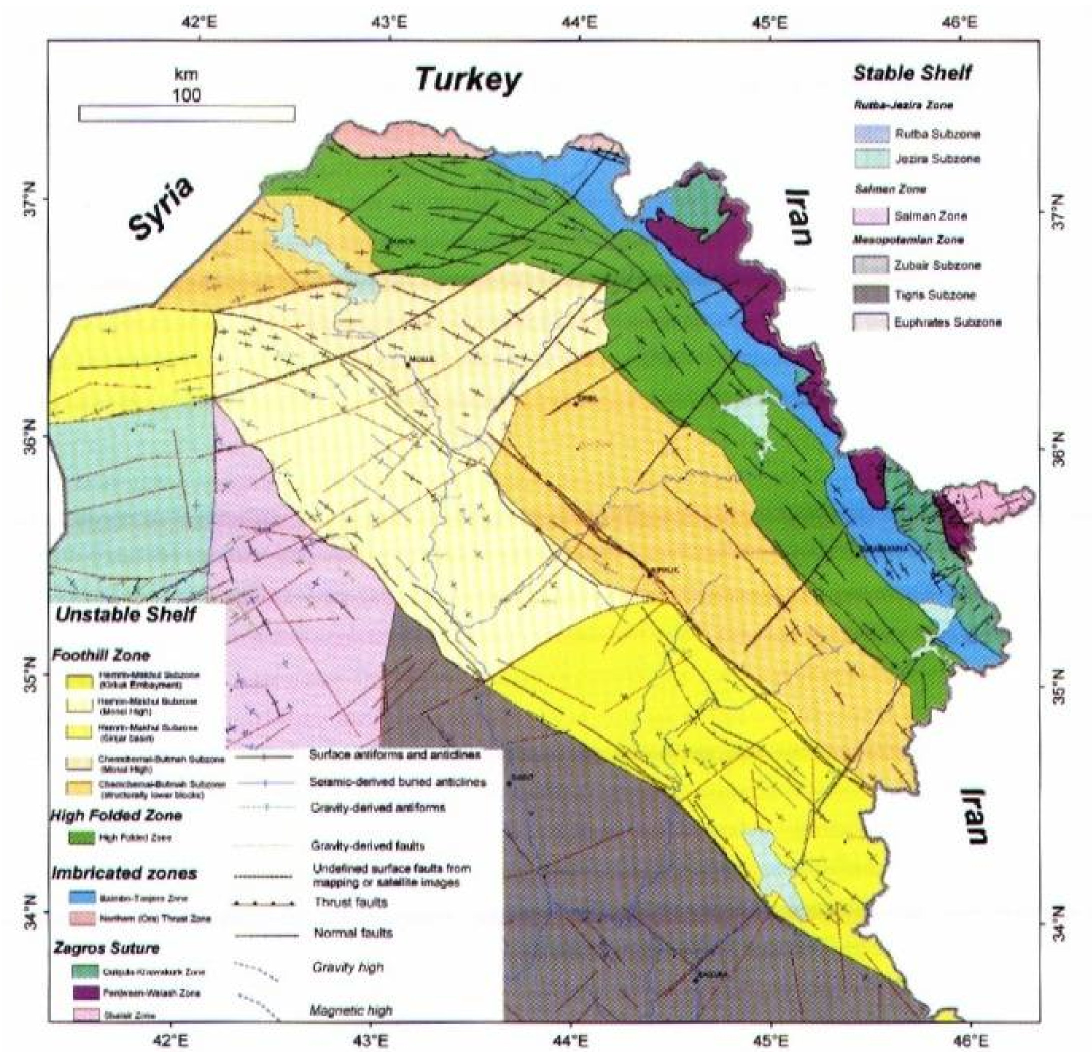

Fig.2: Tectonic zones and structural elements of the Unstable shelf unit. (after Jassim and Goff,2006).

The Red Bed series were deposited under continental conditions ranging from proximal alluvial fan to delta environment (Al-Barazinjy, 2005). Ma'ala (2008) studied the tectonic evolution of the Alpine Tertiary trough in the Chwarta area. This study showed that the Tertiary trough was continuously subsiding and rapidly evolving during short time and considered the Red Beds as linking zone (time and spatial) between periods of the Alpine orgeny in the imbricated zone.

The Section at Chwarta.

The lower layers of the Red Bed section at Chwarta (Fig.3) consist mainly of gravel beds braided channel facies. This facies is represented by thick bed of conglomerates gray color with coarse sand–matrix, locally imbricated and trough cross–bedding and planar–bedding. The facies grade upwards into cross–bedded coarse sandstones, pebbly sandstones, and higher up into clay. The coarse member can be interpreted as longitudinal bars in active channel, its lowermost part is characterized by thick base level transfer cycles (BLTC) cycles where thick floodplain deposits, which represented by massive or thick beds red or brown Claystone and siltstones with thick cross-bedded gray sandstones where higher accommodation resulted from higher rates of subsidence as well as high rates of sediment supply. This part is overlain by thin base level transfer cycles (BLTC) cycles due to reduced accommodation .This may be the result of reduced subsidence rates and /or sediment influx.

The middle part of section is represented by a thick succession of stacked alluvial fan facies (Fig.3) represented by debris flow deposits, They consist of poorly sorted clast supported cobbles and boulder, they are light to dark gray ,massive to crudely stratified and poorly cemented in place.

High uplift in the source area and produced increasing supply with higher rates of subsidence the necessary accommodation for such huge accumulation of this clast supported cobble- and boulder -dominated lithofacies. The upper part of the Red Bed section at Chwarta on the other hand reflects a change in the regime of the deposition where lower rate of subsidence and low river gradient produced aggrading and prograding meandering fluvial system.

The Section at Khewata.

The lower part of Khewata section (Fig.4) is represented by a thick succession of relatively thin BLTC cycles within the gravel bed braided channel facies. This facies is characterized by multistory gravel units in the proximal reaches of such multiple-channel bed load represented by granules and pebbles. This may reflect a balance between accommodation space and sediment influx caused by relative sea level fluctuation du to local change in subsidence rate. This is overlain by thin succession of perennial braided channel facies consisting of thick coarse graind gray sandstones with large scale cross-bedding ,planner- cross stratification .This succession is characterized by thin symmetrical base level transfer cycles (BLTC) Cycles reflecting more balanced situation between reduced subsidence rate and sediment influx (Fig.4)

The top of the section consists of stacked alluvial fan where increased sediment supply and river gradient and rate of subsidence produce this prograding proximal facies.

The Section at Lailuk.

The lower part of the Lailuk section starts with a thick shallow marine carbonate sequence (Fig.5) separated from the lower unconformable boundary with the Tanjero Formation by meandering floodplain facies. This reflects major sea level rise following the lowest and meandering floodplain facies. It consists of massive or thick bed red to brown claystones and siltstones with thin sandstones .It is occasionally laminated. This shallow marine succession is truncated by Type one Sequence Boundary (SB-1) where the succeeding major sea level fall resulted in the carbonate platform exposure and consequent valley incision where thick aggrading prograding gravel bed braided river system due to the rapid fall of base level and increased river gradient.

The upper part of the Red Bed section at Lailuk consists of several asymmetrical BLTC cycles with variable thicknesses (Fig.5) within a meandering fluvial facies. This variability in thickness and asymmetry in cycle reflects the variability in subsidence rates and consequently the accommodation in a distal low gradient setting .This was interbedded in the middle of the section with thin carbonate unit reflecting sudden relative sea level fall due higher subsidence.

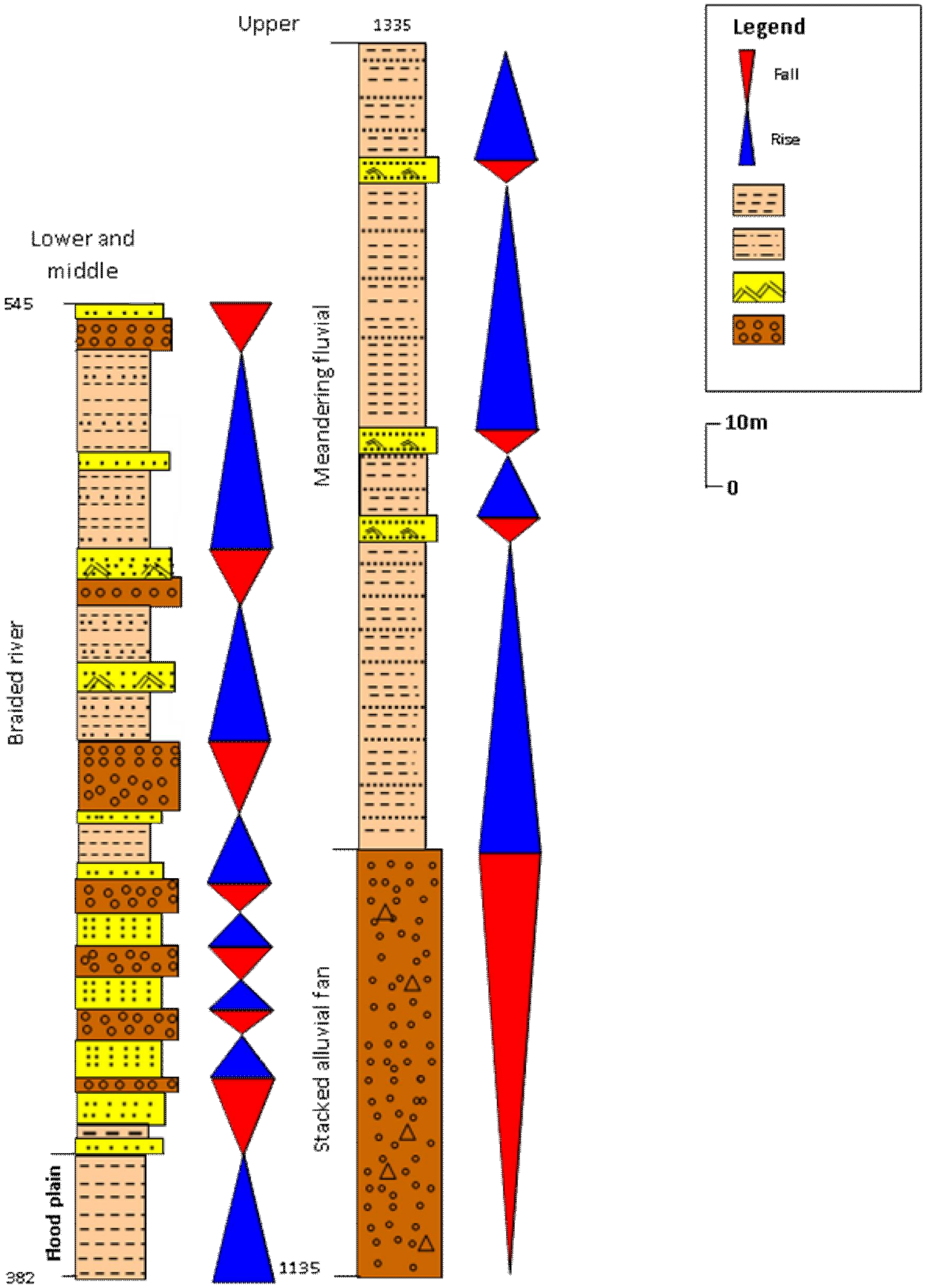

Fig. 3: Sequence stratigrahpic subdivision of the Red Bed succession at Chwarta.

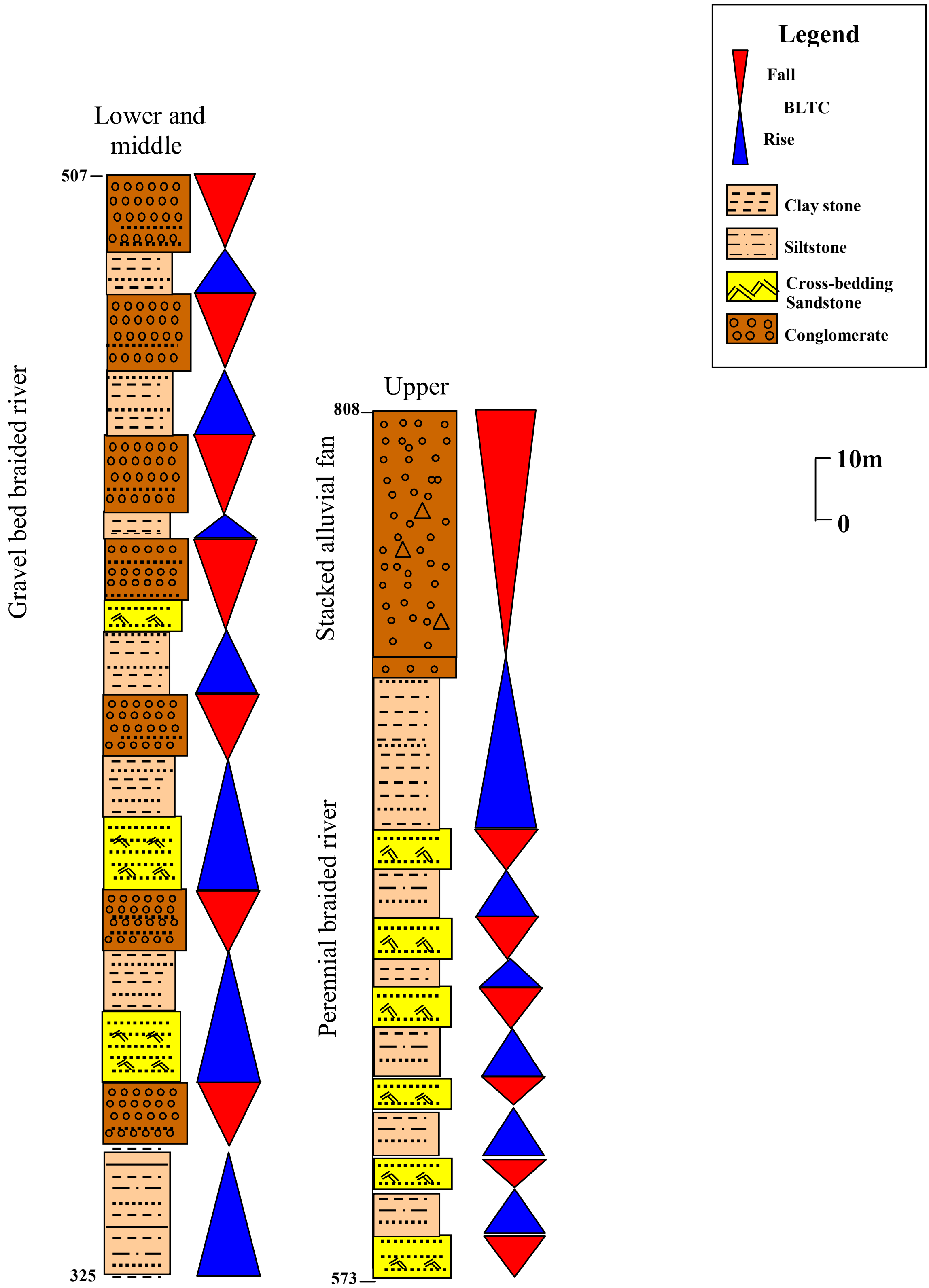

Fig. 4: Sequence stratigrahpic subdivision of the Red Bed succession at Khewata.

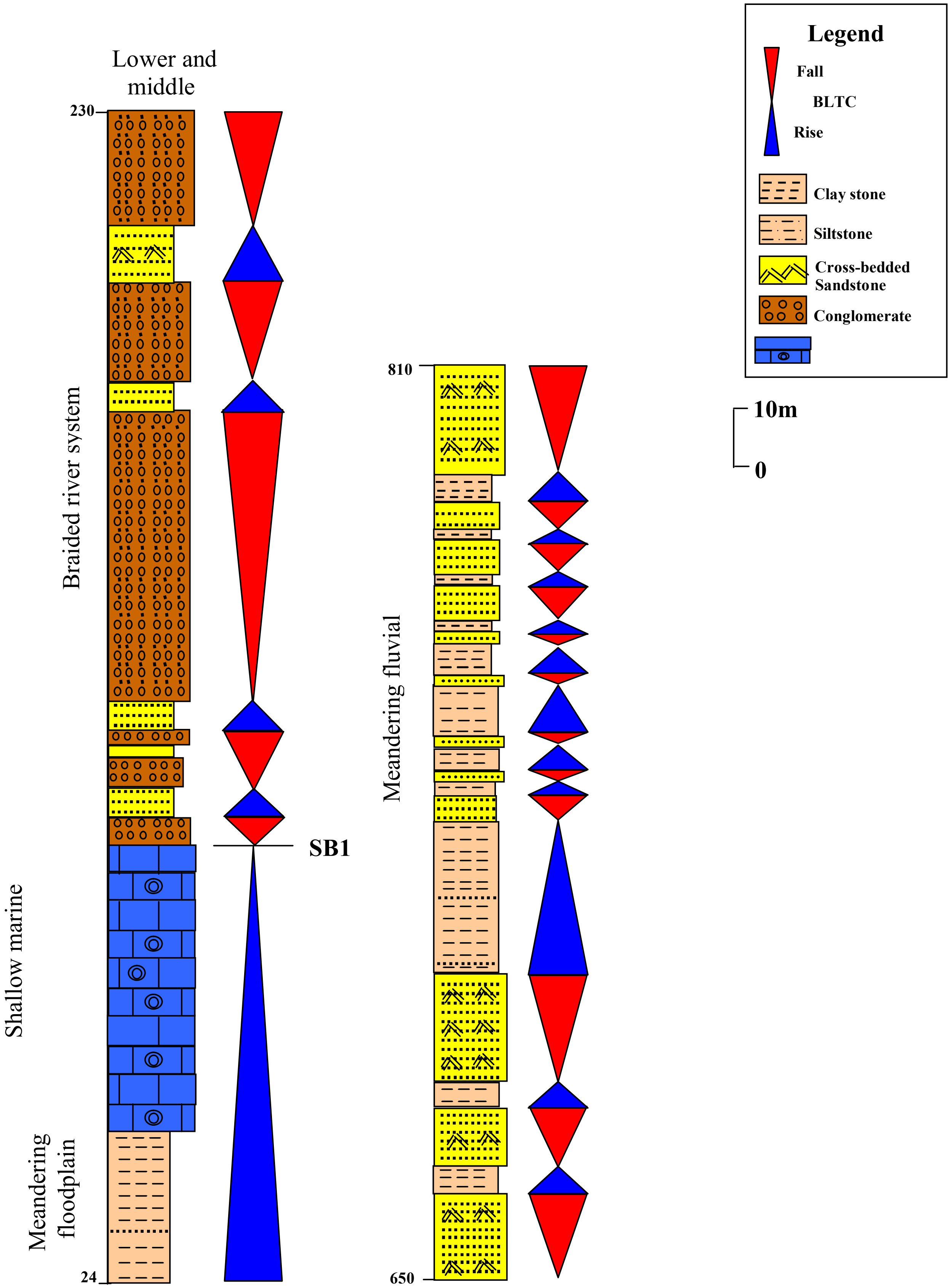

Fig. 5: Sequence stratigrahpic subdivision of the Red Bed succession at Lailuk.

The Section at Piran.

The lower part of the Red Bed succession at Piran (Fig.6) is represented by a number of base level transfer cycles (BLTC) cycles with variable symmetry and thicknesses in meandering river system where the variability of balance between accommodation space and sediment influx produced such succession in this distal low gradient setting with variable rate of subsidence.

The middle part of the section consists mainly of shallow water carbonate intertonguing with floodplain facies reflecting higher eustatic sea level rise and fall in the same distal fan setting .This part (middle)is separated from the upper by a sequence boundary reflecting major sea level fall causing a rapid base level fall where thick prograding meandering river succession was developed (Fig.6).This succession reflects also a variation in accommodation and sediment influx manifested by variable cycle asymmetry and thicknesses. The time of very low rate of subsidence and rapid sea level rise enabled the deposition of thin shallow marine carbonate (Fig.6) intertonguing with the distal floodplain facies.

Basin development.

The Red Bed succession of northern Iraq was developed in an active marginal basin during the Paleocene-Eocene where the final closing of the Neo-Tethys and collision between the northeast Arabian plate with Eurasian plate was taking place. This has caused major uplifts and subsidence episode together with fluctuation of base level due to eustatic rises and falls. This variation throughout the Paleocene and Eocene produced a variability of settings (Fig.7) ranging from proximal alluvial fan to braided river system (gravel bed and perennial) to distal meandering river system.

The Red Bed succession started with the deposition of gravel bed braided channel and perennial braided channel systems in the southeastern part of the study area at Chwarta and Khewata.

The lower part of the Red Bed section at Chwarta is characterized by thick base level cycles represented by thick floodplain deposits as a result of high rates of subsidence and relatively high rates of sediment supply. They are overlain by thin base level transfer cycles (BLTC) cycles caused by reduced accommodation due to reduced subsidence rate and/or sediment influx .The middle part of the Chwarta section is represented by a thick succession of stacked alluvial fan, where high uplift in the source area and increasing supply with higher rates of subsidence produced the neassary accommodation for such huge accumulation of conglomerates.

The upper part of the Red Bed section at Chwarta reflects change in the region of deposition where lower rate of subsidence and low river gradient produced aggrading and prograding succession.

On the other hand, in the lower part of Khewata section the Red Bed succession reflects thin BLTC cycles within the gravel bed braided channel facies. This may reflect a balance between accommodation space and sediment influx caused by relative sea level fluctuation due to local change in succession of perennial braided channel facies, characterized by thin asymmetrical BLTC cycles reflecting more balanced situation between subsidence rate and sediment influx. The upper part of the section consists of stacked alluvial fan where increased sediment supply and river gradient, and rate of subsidence were produced.

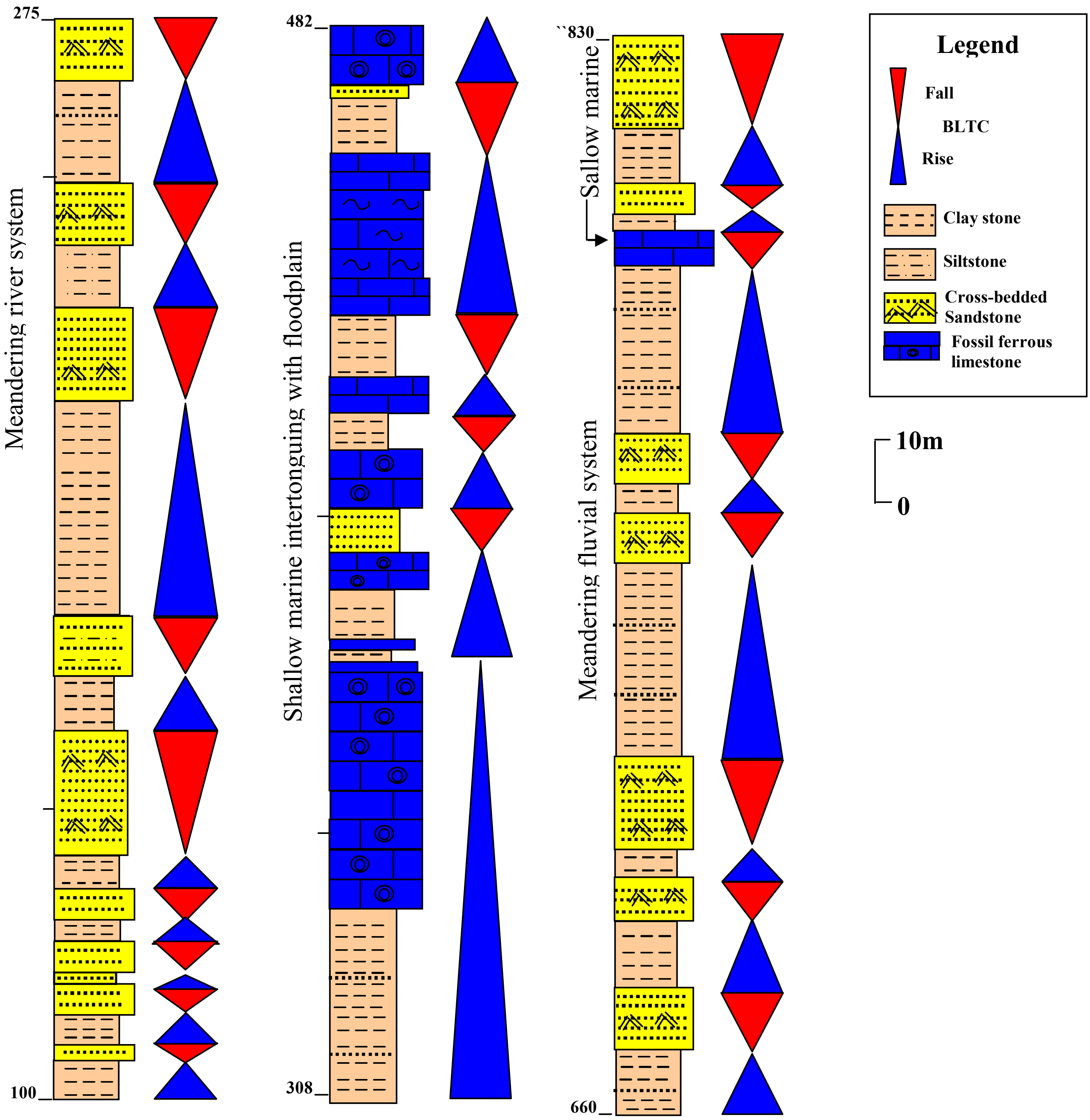

Fig. 6: Sequence stratigraphic subdivision of the Red Bed succession at Piran.

The thick succession of stacked alluvial fan at southeastern part of the study area at Chwarta and Khewata may reflect fan growth during continued faulting and uplift of source area and/or subsidence of the region followed by retreat of the scarp front and lowering of relief in the highlands (Fig.7)

The succession at Lailuk and Piran to the northwest reflects a change in setting into distal fan area, meandering river systems, and shallow open marine carbonates (Fig.7). In the lower part of Lailuk section the deposits reflect a major sea level rise represented by shallow open marine carbonate facies following a lowstand meandering floodplain. This shallow marine succession was truncated by Type-one sequence boundary(SB-1) where the succession major sea level fall resulted in the carbonate platform exposure and consequent valley incision due to the rapid fall of base level and increased river gradient.The upper part of the Red Bed section at Lailuk reflects variability in thickness and asymmetrical in cycle within a meandering fluvial facies, caused by variability in subsidence rate and consequently the accommodation in a distal low gradient setting .This was interbedded in the middle of the section with thin carbonate unit reflecting sudden relative sea level rise due to higher subsidence rate. Towards the northwest of Lailuk section, the Red Bed at Piran, the lower part of the succession, show variable cyclicity by thickness in meandering river system result from balance between accommodation space and sediment influx produced in distal low gradient setting with variable rate of subsidence.

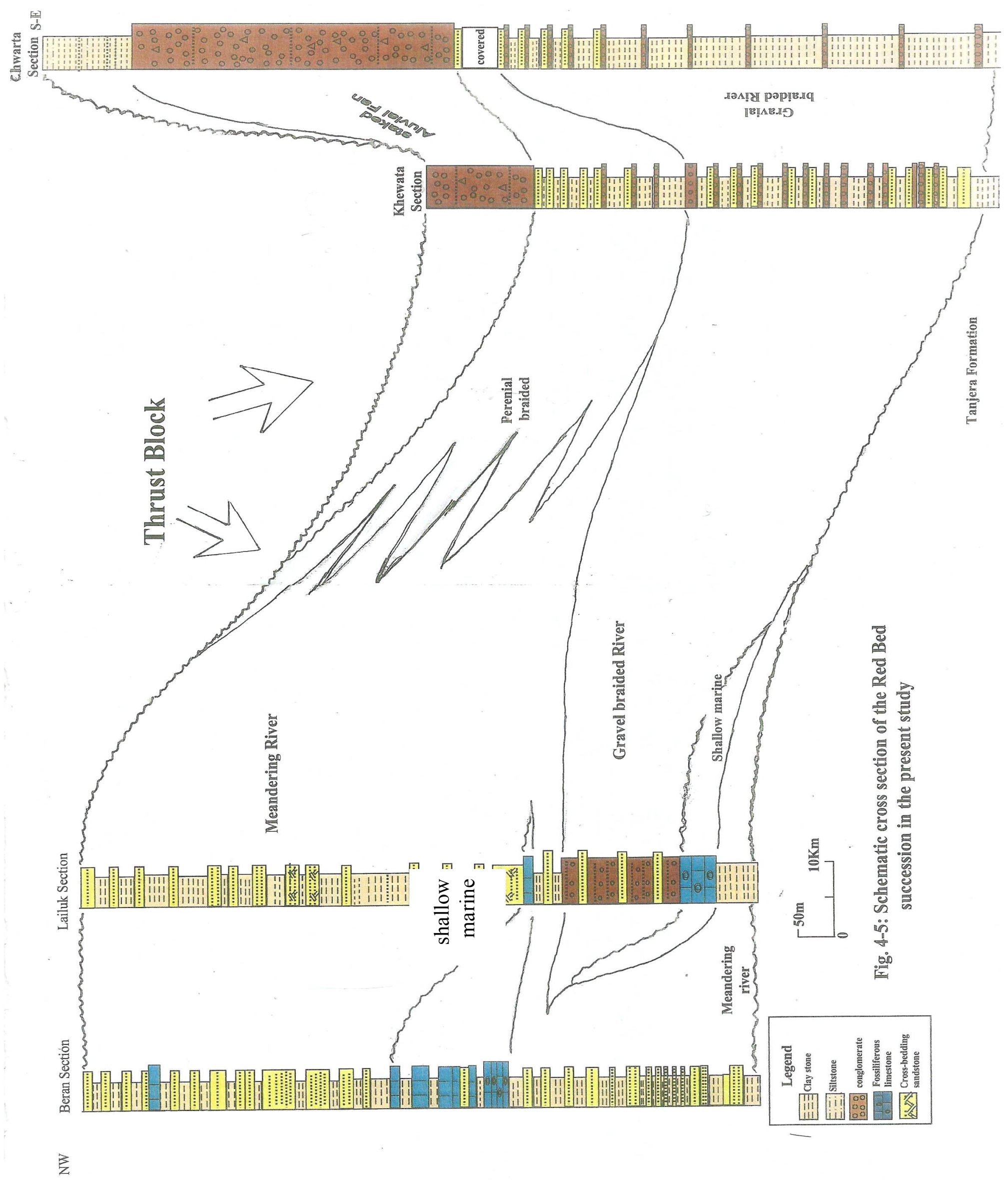

Fig. 4-5: Schematic cross section of the Red Bed succession in the present study

The middle part of the section represented by shallow marine carbonate intertonguing with floodplain reflecting high eustatic sea level rise and fall in distal fan setting .This part is separated from the upper part by a sequence boundary reflecting major sea level fall causing rapid base level fall where thick prograding meandering river succession reflect also a variation in accommodation and sediment influx manifested by variable cycle asymmetry and thickness.

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