



Microfacies analysis and depositional development of Shuaiba formation in the West Qurna oil field, Southern Iraq

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Abstract

The Aptian carbonate succession in this study is represented by the Shuaiba Formation which was deposited during the Early Cretaceous. The present study is including petrography and microfacies analysis for four boreholes WQ-12, WQ-13, WQ-15, and WQ-178 within the West Qurna oil field. There are four major microfacies recognized in the succession of the Shuaiba Formation, bioclastic mudstones to wackestone, *Orbitolina* wackestone to packstone, Peloidal wackestone to packstone, Miliolids wackestone, and Planktonic and small benthic mudstone to wackestone. The four depositional environments deposited in the Shuaiba Formation are; shallow open marine, Semi-restricted, restricted, and outer ramp environments. The Shuaiba Formation was deposited during two stages of transgression and a high stand of sea level. The first during the change of deltaic—fluvial environment of the Zubair Formation which became open shallow marine environment of the lower part of Shuaiba Formation. The presence of restricted facies overlying the shallow open marine refers to still stand sea level and deposition of high stand deposits and marked the first maximum flooding surface (mfs1). After the high stand deposits and within the upper part the Shuaiba Formation, the facies appeared further deepening upward with observed outer ramp facies to mark the transgressive stage. The second time, overlying the semi-restricted facies for the deeper facies refers to the second stage of still standing sea level (high stand deposits) within the Shuaiba Formation and marks maximum flooding surface (mfs2). The high stand deposits continued shallowing upward until the sea level and fell in all parts of southern Iraq to deposit the deltaic-fluvial deposits of Nahr Umr Formation. This marks the regression stage and sequence boundary type which separates the Shuaiba Formation and Nahr Umr Formation.

Keywords Sedimentology · Facies analysis · Shuaiba formation · West Qurna oil field · Southern Iraq

Introduction

The Aptian carbonate succession in this study is represented by the Shuaiba Formation which was deposited during the Early Cretaceous within the Thamama Group (Fig. 1). The present study is including petrography and microfacies analysis to determine the lithological variation and facies changes to interpret the depositional environment and basin development on these properties for studied succession in four boreholes WQ-12, WQ-13, WQ-15, and WQ-178 within the West Qurna oil field (Fig. 2).

The Shuaiba Formation was first defined by Owen and Nasr, 1958 in Bellen et al. 1959 from well Zubair-3 in S Iraq.

It comprises 62 m of pseudo-oolitic limestone, sometimes sandy, fine-grained organodetrital limestone grading into the chalky limestone and limestone with shale streaks near the top. It contains *Orbitolina* cf. *discoidea* Gras, *Choffatella decipiens* Schlumberger (at the base only), and globigerinoides which (together with the stratigraphic position of the formation) indicate an Aptian age. The formation overlies and passes laterally into the Zubair Formation with a conformable and gradational contact. The upper contact is associated with a 6 Ma break in Kuwait (Douban and Medhadi 1999). The average thickness of Shuaiba Formation in the studied area ranges from (73 m in WQ-148 to 181 m in WQ-178) (Fig. 2b).

Al-Zaidy and Amer (2015) studied the microfacies analysis and diagenetic features development of Shuaiba Formation within Albian—Aptian Succession in the West Qurna oil field. Five major microfacies were recognized in this

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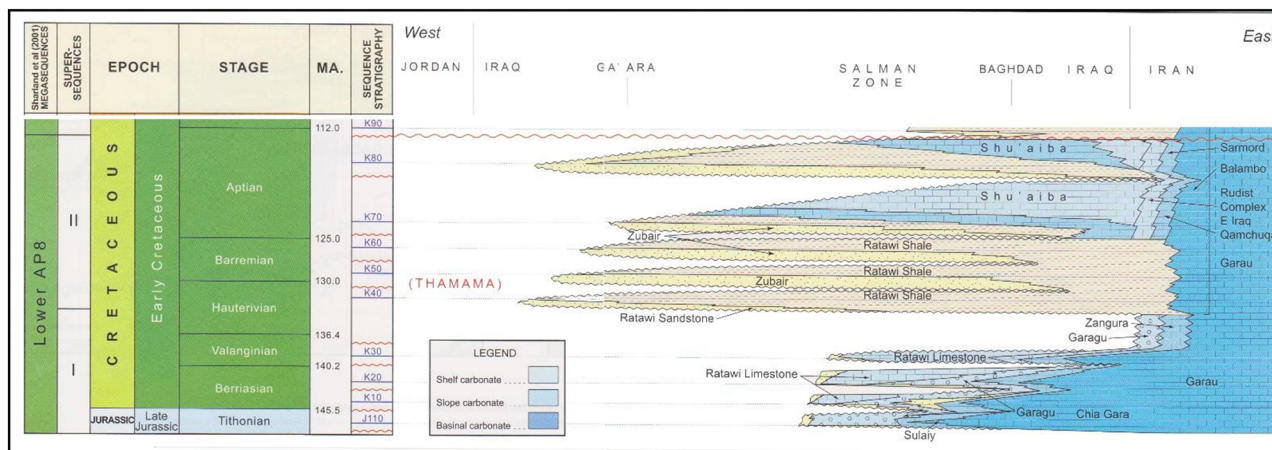


Fig. 1 Stratigraphic cross section showing the Shuaiba Formation within Thamama Group (Aqrabi et al. 2010)

study which deposited from an open shelf toward the deep basin.

Methodology

The present study is divided into three work stages:

1. Field observation and sampling stage
This stage is represented by going to the West Qurna oil field where the studied section describes and collecting the samples.
2. Laboratory stage
 - During this stage, the samples were chosen and made a thin section.
 - Petrographic study and microfacies analysis are based on the exam of more than 200 thin sections of cutting from the selected borehole (WQ 12), (WQ-13), (WQ-15), and (WQ-178) (Table 1). The cutting samples are provided by the southern oil company and prepared by the author.

Results and discussion

Petrography

The Shuaiba Carbonate Formation is classified according to Dunham (1962). Microfacies are determined according to the types of grains (skeletal and non-skeletal) as well as the depositional textures. Five major carbonate microfacies were recognized in this succession; based on their characteristic grain types and depositional texture enabled the recognition of the paleoenvironment (Figs. 3, 4, 5, and 6).

Four depositional environments can be recognized within the Shuaiba Formation according to Wilson (1975), Flugel (2010), and (Boudagher 2008).

Microfacies (A): bioclastic mudstones to wackestone

The microfacies A is mainly composed of micrite with bioclasts of mollusk, echinoderms, and calcareous algae (Plt 1.a). This microfacies reflects and represent the deposition in shallow open marine.

Microfacies (B): orbitolinal wackestone to packstone

The second most common carbonate microfacies in Shuaiba Formation is the Orbitolina—bearing wackestone to packstone. With few bioclast of mollusk and rudist, addition to echinoderm, and calcareous algae (Plt 1.b). This may reflect and represents the deposition in semi-restricted shallow marine.

Microfacies (C): peloidal wackestone to packstone

This microfacies is consisting mainly of peloids with rudist bioclasts, calcareous algae, and miliolids being the less abundant. It can be divided into:

1. Peloidal miliolid wackestone to packstone which characterized by rounded shape grains, from their biform size, ovoid shape where the dominance of relatively coarse to fine sand-sized and moderately sorted peloids (Plt 1.c).
2. pelletal wackestone to packstone is characterized by the abundance of the uniformly of small particle size and consistent shape of these grains (silt-sized well-sorted pellets) (Plt 1.e).

Fig. 2 Location and tectonic map of the Study area according to Fouad (2014)

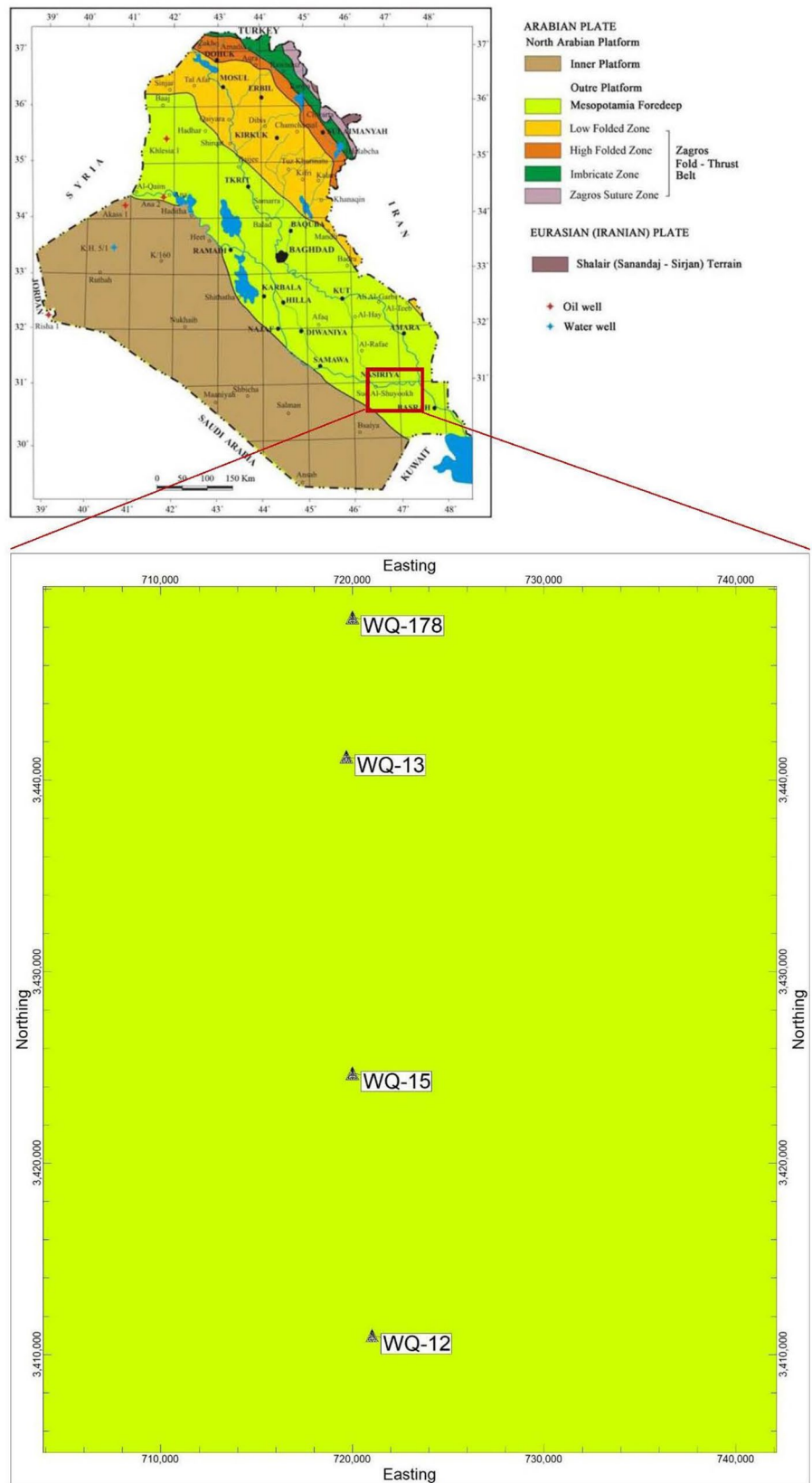


Table 1 The interval sampling number of sample and thin section number

Well No	Easting	Northing	Thickness	Sample no	Thin section no
WQ 12	721,030	3410,990	97.1	50	45
WQ 13	719,863	3444,122	101	60	55
WQ 15	720,000	3424,700	90	72	65
WQ 178	720,000	3448,500	105.7	43	40

Microfacies (D): miliolids wackestone

The main constituents are miliolids with few Nezzazata and small benthic foraminifera, and addition to echinoderm bioclasts and algae (Plt 1.d). This microfacies is reflects and represents a restricted shallow environment.

Microfacies (E): planktonic small benthic mudstone to wackestone

This microfacies is a less common and uncertainly distinguished in all most wells. It is composed of planktonic foraminifera such as *Globigerina* spp. and other small benthic foraminifera (Plt 1.f). This microfacies is identified as a deposition in open shelf toward the deep basin.

Depositional history

The basin developed during the Early Cretaceous (Barremian–Aptian) from the high stand (still stand sea level) when deposited at the Zubair Formation during the Barremian; to the transgression stage and deposited the Shuaiba Formation within the longitudinal basin (Fig. 7).

The Shuaiba Formation was deposited during two stages of transgression and a high stand of sea level. The first during the change of deltaic—fluvial environment of Zubair Formation to become open shallow marine environment of the lower part of Shuaiba Formation (Fig. 8). The presence of restricted facies overlying the shallow open marine refers to still stand sea level and deposition of the high stand deposits and marked the first maximum flooding surface (mfs1). After the high stand deposits and within the upper part of the Shuaiba Formation, the facies appeared deepening upward with observed the outer ramp facies to mark the transgressive stage. The second time of overlying the semi-restricted facies for the deeper facies refers to the second stage of still

standing sea level (high stand deposits) within the Shuaiba Formation and mark the maximum flooding surface (mfs2) (Fig. 8). The high stand deposits continued as shallowing upward until the sea level fell in all parts of southern Iraq to deposit the deltaic-fluvial deposits of Nahr Umr Formation. This refers to the regression stage and marks sequence boundary type one between the Shuaiba Formation and Nahr Umr Formation.

Conclusions

The Aptian carbonate succession in this study is represented by the Shuaiba Formation, which was deposited during the Early Cretaceous. The present study includes petrography and microfacies analysis for fore boreholes within the West Qurna oil field in the study area.

The microfacies analysis appeared four major microfacies were recognized in the succession of the Shuaiba Formation, Bioclastic mudstones to wackestone, Orbitolina wackestone to packstone, Peloidal wackestone to packstone, Miliolids wackestone, and Planktonic small benthic mudstone to wackestone. There four depositional environments were deposited on the Shuaiba Formation namely: shallow open marine, semi-restricted, restricted, and outer ramp environments.

The Shuaiba Formation was deposited during two stages of transgression and a high stand of sea level. The first during the change of deltaic—fluvial environment of Zubair Formation to become open shallow marine environment of the lower part of Shuaiba Formation. The presence of restricted facies overlying the shallow open marine refers to still stand sea level and deposition of the high stand deposits and marked the first maximum flooding surface (mfs1). After the high stand deposits and within the upper part the Shuaiba Formation the facies is appeared deepening upward with observed the outer ramp facies to mark the transgressive stage. The second time of overlying the semi-restricted facies for the deeper facies refers to the second stage of still standing sea level (high stand deposits) within the Shuaiba Formation and mark the maximum flooding surface (mfs2) (Plate 1).

The high stand deposits continued shallowing upward until the sea level fell in all parts of southern Iraq to deposit the deltaic-fluvial deposits of Nahr Umr Formation. This marks the regression stage and sequence boundary type between the Shuaiba Formation and Nahr Umr Formation.

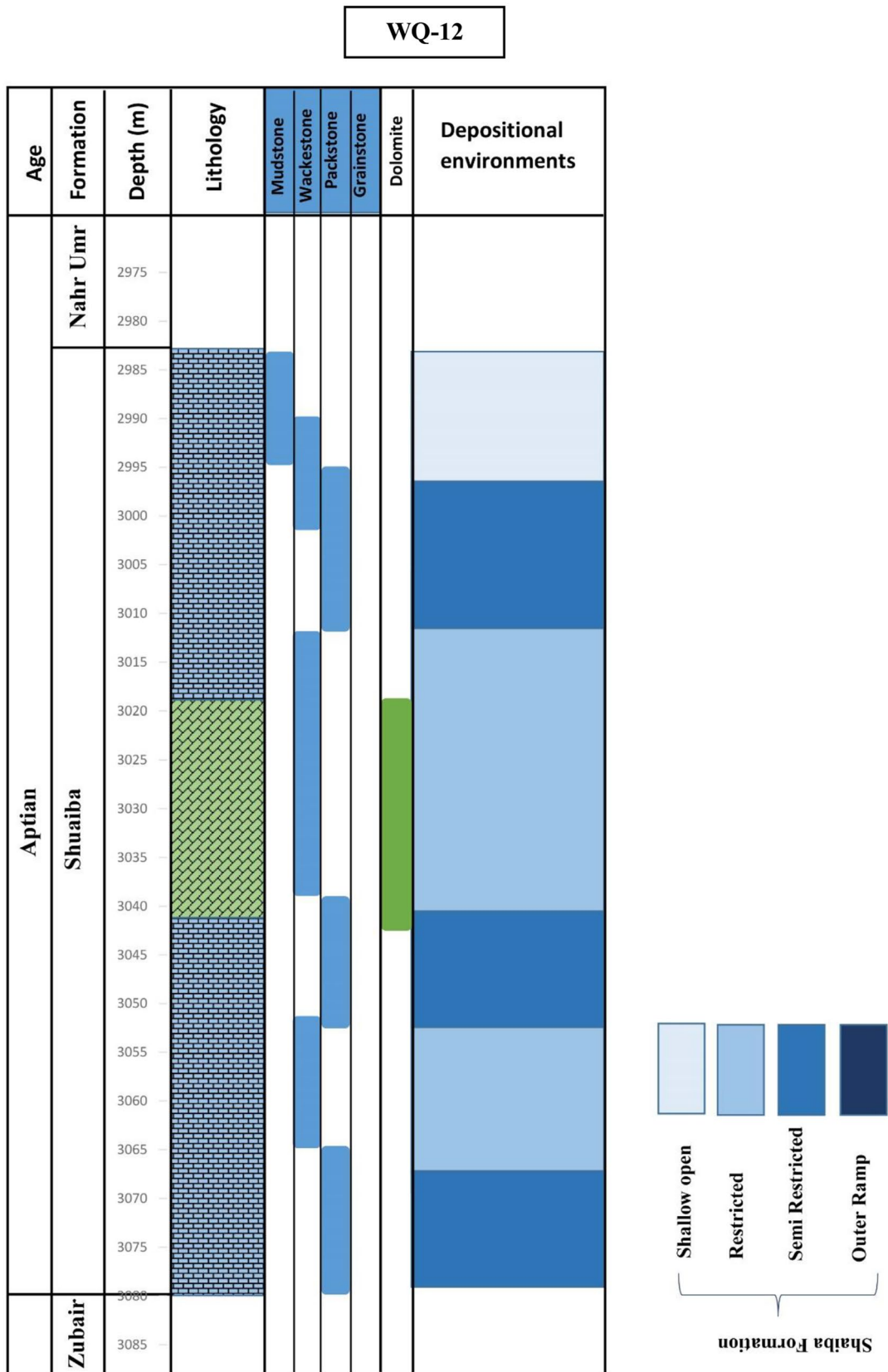
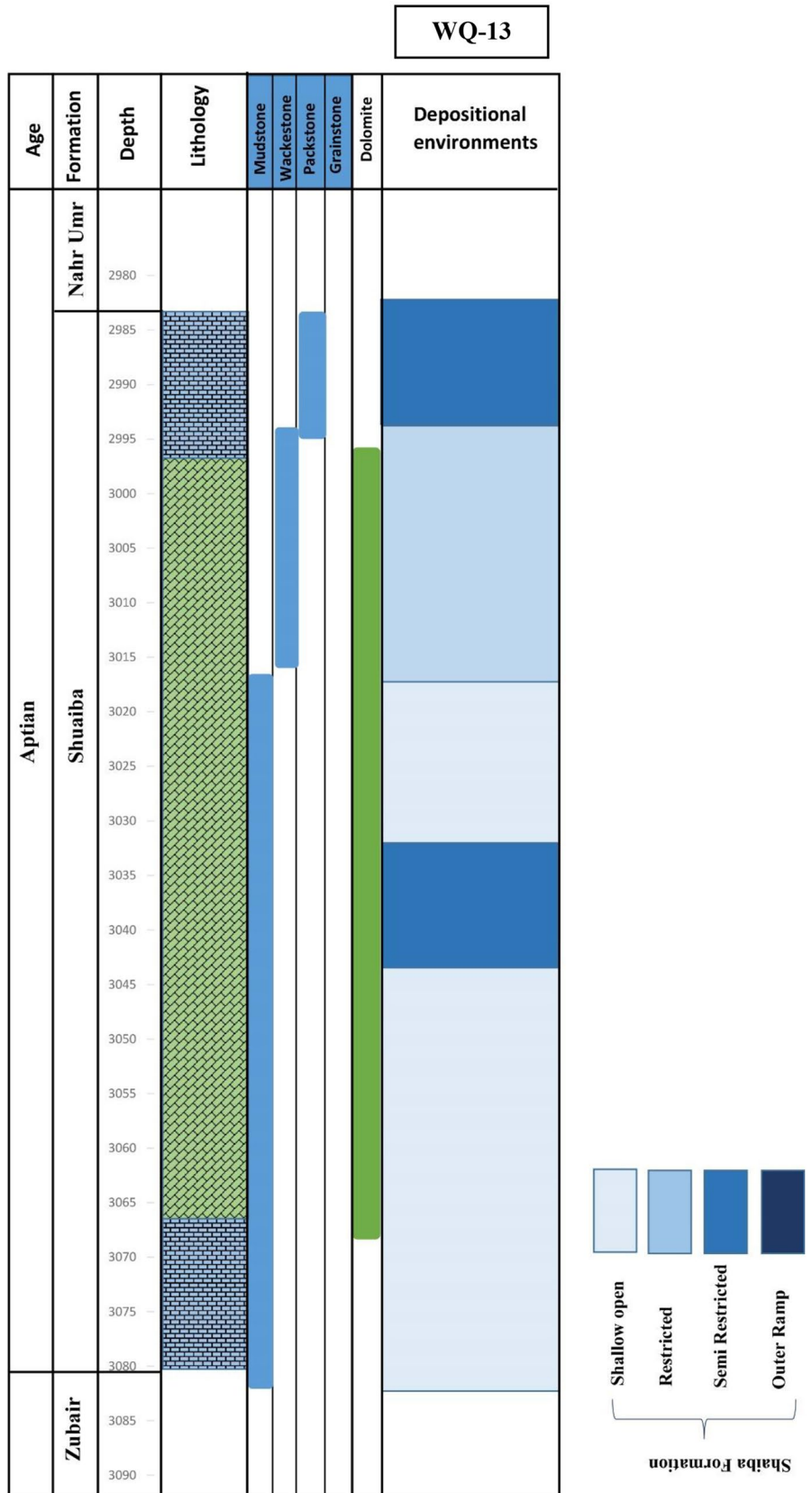


Fig. 3 WQ-12: columnar section showing the carbonate fabric and sedimentary environments of Shuaiba Formation

Fig. 4 WQ-13: columnar section showing the carbonate fabric and sedimentary environments of Shuaiba Formation



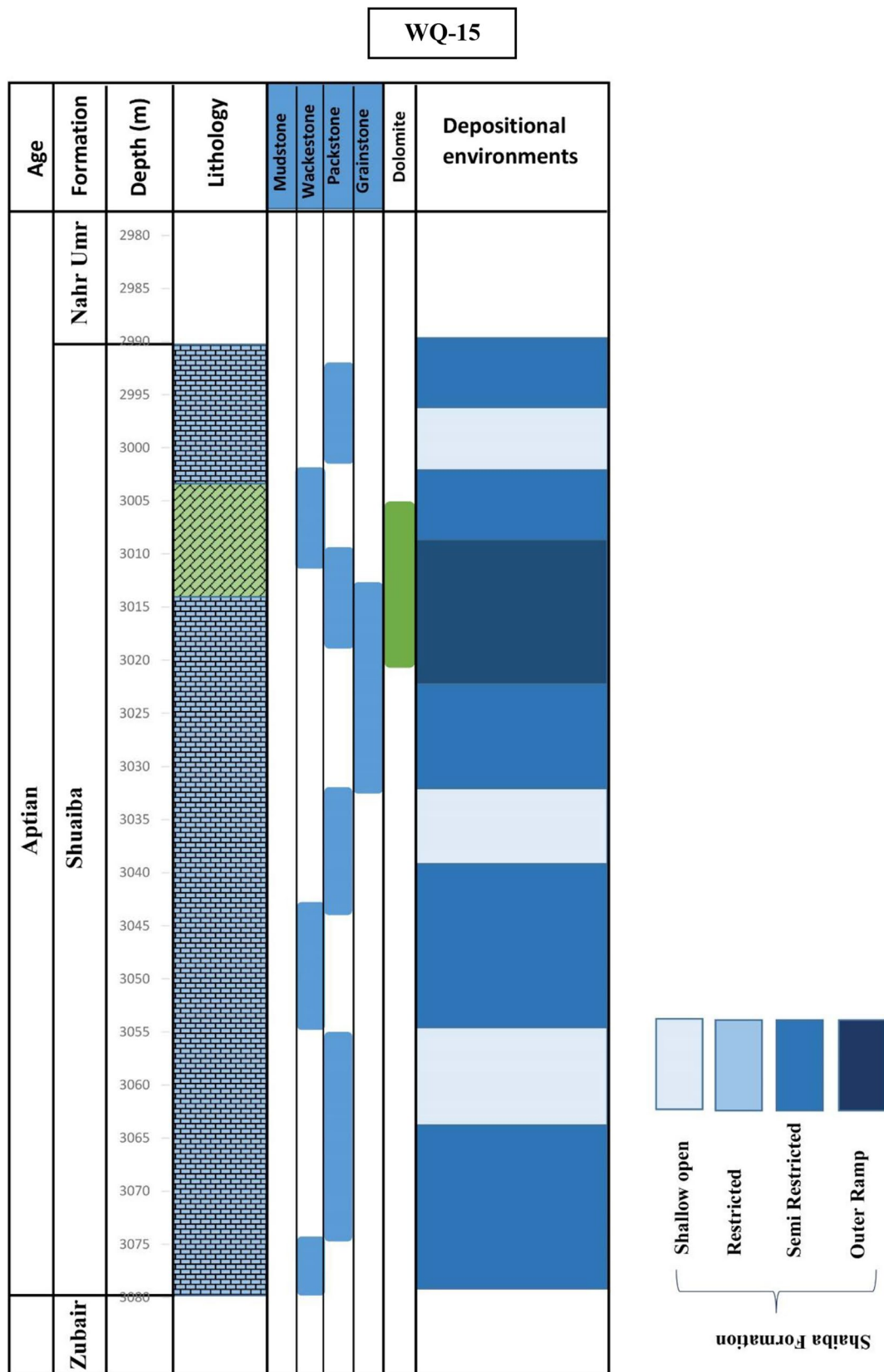


Fig. 5 WQ-15: Columnar section showing the carbonate fabric and sedimentary environments of Shuaiba Formation

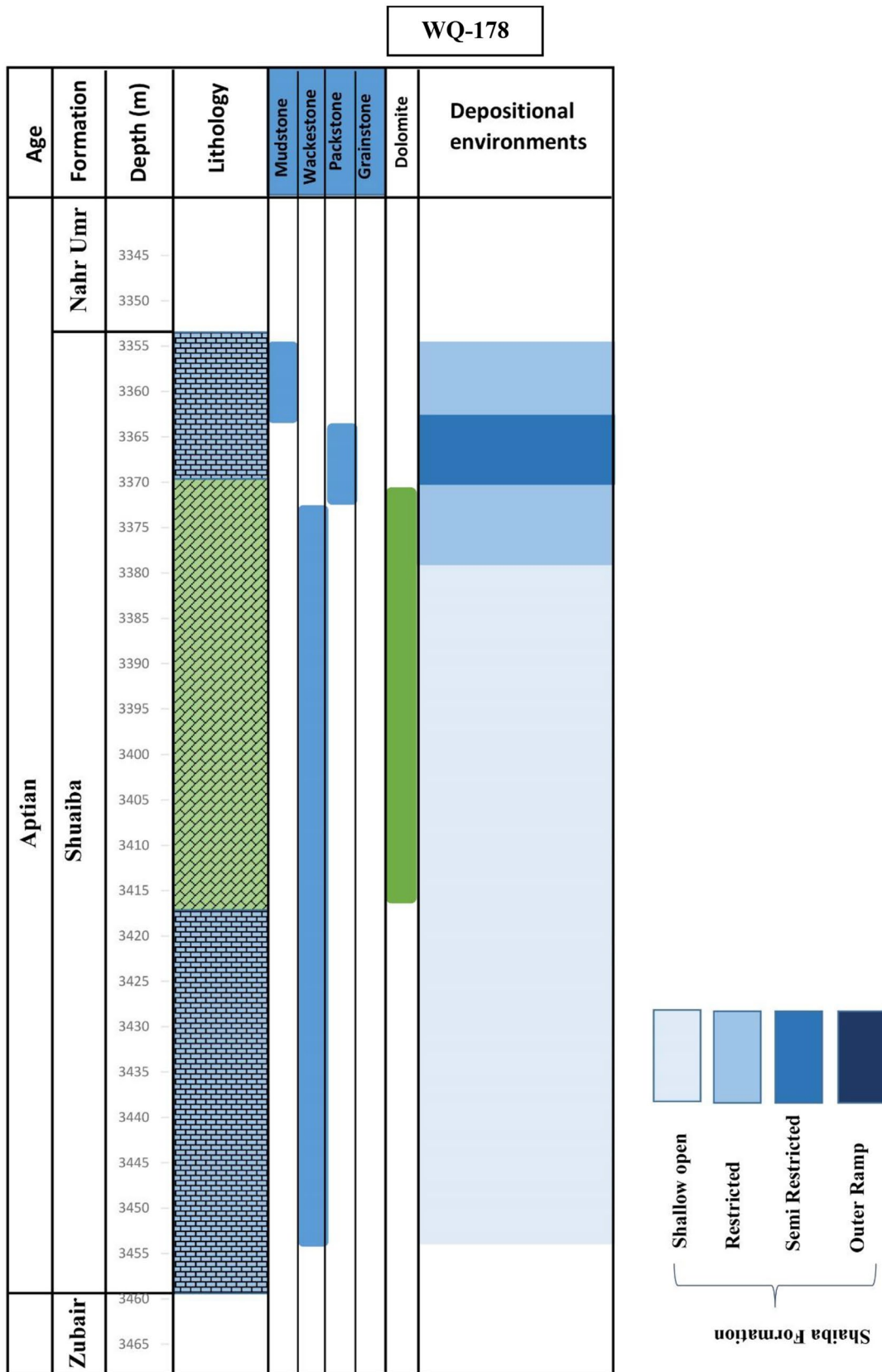


Fig. 6 WQ-178 Columnar section showing the carbonate fabric and sedimentary environments of Shuaiba Formation

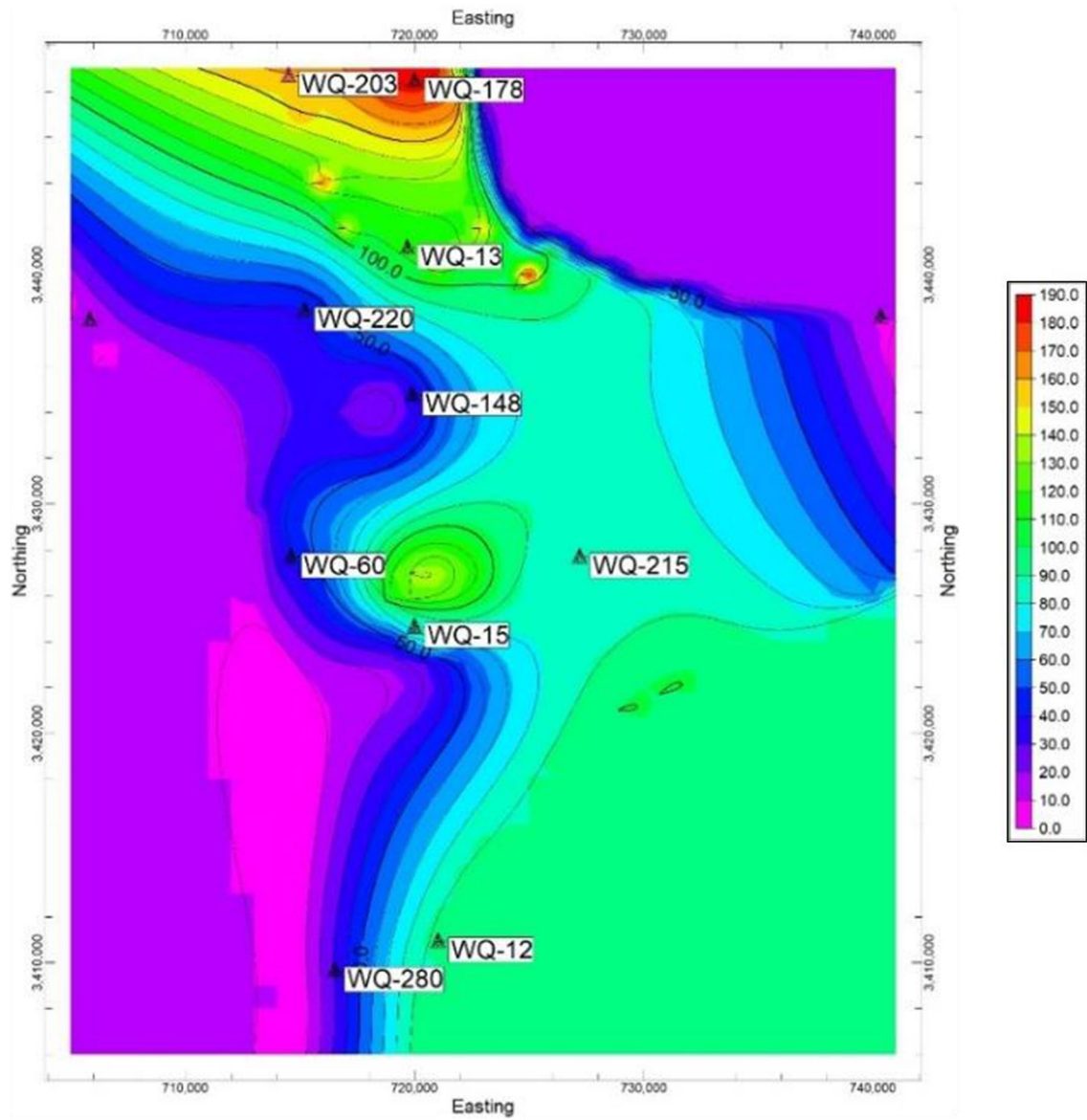


Fig. 7 Isopach map of Shuaiba formation in West Qurna oil field

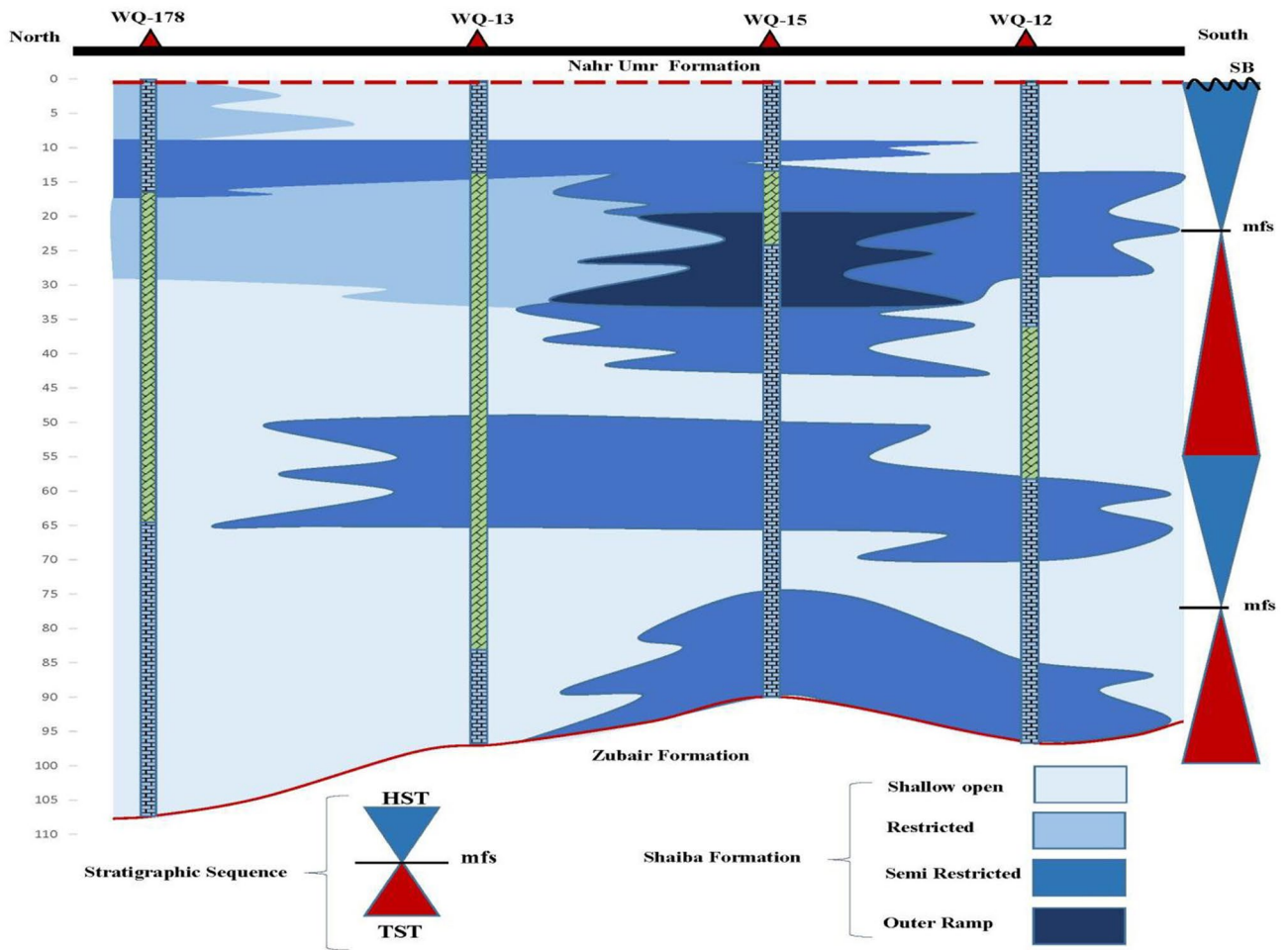


Fig. 8 Stratigraphic cross section showing vertical and lateral facies changes

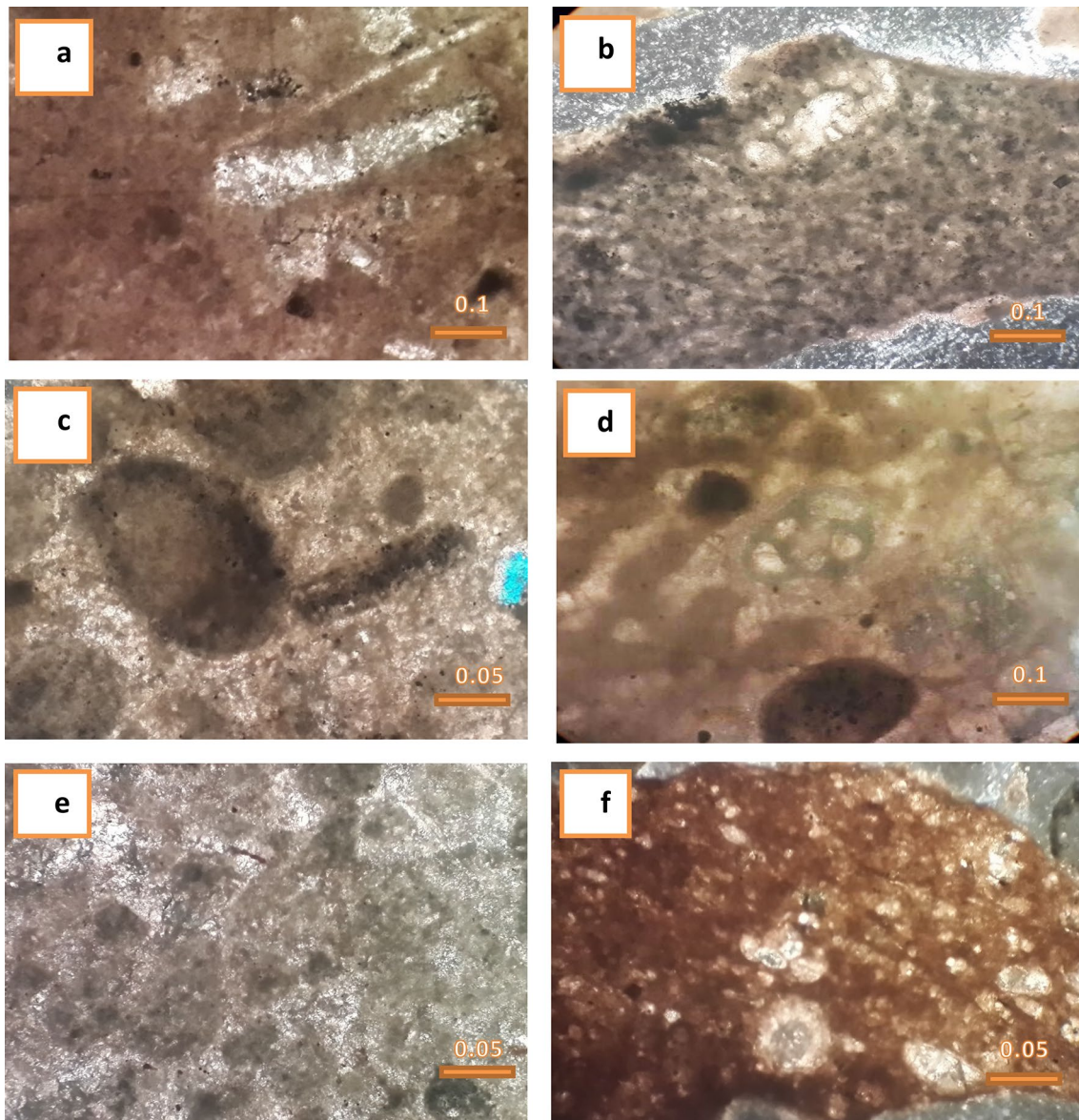


Plate 1 Microfacies types of studied sections. **a** bioclastic mudstones to wackestone (Facies a). (WQ -15, depth 3250 m), **b** Orbitolina wackestone to packstone (Facies b). (WQ -178, depth 3315 m), **c** Peloidal wackestone to packstone (Facies d). (WQ -178, depth 3335

m), **d** Miliolids wackestone (Facies c). (WQ -13, depth 3350 m), **e** pelletal wackestone to packstone (Facies d). (WQ -178, depth 3365 m), **f** Planktonic benthic mudstone to wackestone (Facies d). (WQ-15, depth 3350 m)

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