



Full Length Article

Facies-controlled diagenesis and its impact on reservoir quality of carbonate sequences: Cretaceous Sarvak Formation in the Zagros Basin, Iran

Hanieh Mollaali ^{a,b}, Hamzeh Mehrabi ^{a,*}, Mohammadfarid Ghasemi ^b

^a School of Geology, College of Science, University of Tehran, Tehran, Iran

^b Faculty of Earth Sciences, Shahid Beheshti University, Tehran, Iran

ARTICLE INFO

Article history:

Received 16 April 2025

Received in revised form

28 July 2025

Accepted 29 July 2025

Available online 5 August 2025

Keywords:

Carbonate diagenesis

Sequence stratigraphy

Reservoir heterogeneity

Hydraulic Flow Units (HFUs)

Zagros Basin

ABSTRACT

The Cretaceous Sarvak Formation in the Zagros Basin exhibits complex reservoir heterogeneity controlled by depositional facies and sequence stratigraphy-constrained diagenesis. This study integrates petrographic and petrophysical analyses of an Abadan Plain oilfield to establish predictive relationships between microfacies, diagenesis, and automated hydraulic flow units (HFUs). Eight microfacies were identified, representing four depositional environments: open marine, shoal complex, patch-reefs, and lagoon, supporting a ramp model. Reservoir quality varies systematically across four HFU classes, ranging from poor (HFU1: 0–0.1 FZI, 2.76 mD permeability, 10.85% porosity) to excellent (HFU4: >0.7 FZI, 45.99 mD permeability, 17.4% porosity). Diagenetic processes show distinct relationships with sequence stratigraphy: marine cementation dominates transgressive systems tracts, while meteoric dissolution and fracturing prevail in regressive systems tracts and at sequence boundaries. Maximum flooding surfaces record chemical compaction and authigenic mineralization. Facies-selective diagenesis primarily controls reservoir quality. Grain-supported facies develop dissolution-enhanced porosity, whereas mud-dominated facies experience porosity reduction through cementation and compaction. Dolomitization and fracturing provide secondary permeability enhancement, particularly in mid-ramp settings. HFU classification reveals optimal reservoir performance in zones where dissolution and fracturing enhance pore networks (HFU3–HFU4). In contrast, non-reservoir zones (HFU1–HFU2) are affected by extensive cementation and compaction. These findings highlight the predictive potential of integrating sequence stratigraphy with diagenetic analysis for reservoir characterization in carbonate systems. The established facies-to-diagenesis relationships provide a robust framework for understanding reservoir heterogeneity and fluid flow behavior in the Sarvak Formation and analogous carbonate reservoirs.

© 2025 Chinese Petroleum Society. Publishing services by Elsevier B.V. on behalf of KeAi Communications Co. Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Hydrocarbon field exploration, development, and production programs are often complex and expensive, necessitating a thorough understanding of geological and reservoir conditions to mitigate risks and costs (Bahrami et al., 2022). Diagenetic studies serve as a precise method for assessing reservoir quality in both clastic and carbonate sequences (Kordi et al., 2011; Macedo Penna

et al., 2024). Additionally, sequence stratigraphic analyses elucidate sedimentation patterns in spatial and temporal contexts, as well as their relationship to relative sea-level fluctuations (Abedi et al., 2025). This approach aids in predicting facies distribution and provides insights into primary porosity and permeability (Jafarian et al., 2024; Marghani et al., 2023). However, these properties are often altered by diagenetic processes. Recent research highlights the combined application of sequence stratigraphy and diagenesis as an effective tool for predicting diagenetic modifications and their impact on reservoir quality evolution (Abedi et al., 2025; Morad et al., 2013).

In carbonate reservoirs, reservoir properties and heterogeneities are controlled by combined effects of depositional facies

* Corresponding author.

E-mail addresses: mehrabi.hamze@ut.ac.ir, hmehrabi.ut@gmail.com (H. Mehrabi).

Peer review under the responsibility of Editorial Office of Petroleum Research.

characteristics, diagenetic processes and fracturing (Ahr, 2008; Daraei et al., 2017; Fallah-Baghtash et al., 2025). A major portion of these controlling factors can be related to the sequence stratigraphic framework (Hammer et al., 2010; Khodaei et al., 2021; Morad et al., 2012). Linking diagenesis to sedimentary facies and, consequently, to sequence stratigraphic framework, is a key step in geological analysis of carbonate hydrocarbon reservoirs (Abedi et al., 2025; Cao et al., 2018; Sharifi-Yazdi et al., 2020a,b). Understanding the distribution of depositional facies is essential for accurately modeling the reservoir because they reflect the original sedimentary environments and depositional energy levels, which subsequently control porosity and permeability trends (Jafarian et al., 2025; Shehata et al., 2021). On the other hand, diagenetic processes further modify the reservoir characteristics by altering the pore structure, which can either enhance or degrade the reservoir's storage and flow properties (Javed et al., 2023; Tavakoli and Barfizadeh, 2024).

The Upper Cretaceous carbonate successions, including the Sarvak and Ilam formations, are important hydrocarbon reservoirs in the Middle East, particularly in the Zagros Basin (Mehrabi et al., 2020; Bagherpour et al., 2021). The Sarvak Formation is second-largest oil reservoir of Iran, after the Oligocene-Miocene Asmari Formation (Mehrabi, 2023; Yahyaei et al., 2025). Due to its importance, the Sarvak Formation was the subject of several studies focusing on its sedimentology (Abbasi et al., 2024; Esfandiyari et al., 2023; Mehrabi et al., 2024; Mehrabi and Rahimpour-Bonab, 2014), palaeontology (Omidvar et al., 2014), geochemistry (Navidtalab et al., 2016; Mehrabi et al., 2022a, 2022b) and reservoir quality (Foroshani et al., 2023; Malekzadeh et al., 2020; Mehrabi and Bagherpour, 2022; Mehdipour et al., 2023). Despite these studies, the relationship between sedimentary facies and diagenetic processes within the sequence stratigraphic framework of this formation has received less attention.

This study aims to investigate the facies-controlled diagenetic processes influencing the reservoir quality of the Cretaceous Sarvak Formation in the Zagros Basin, Iran. By integrating sedimentological, petrographical, and petrophysical analyses, we seek to unravel the complex interplay between depositional facies and diagenetic alterations, including cementation, dissolution, and dolomitization, and their subsequent impact on porosity and permeability evolution. Furthermore, this research evaluates how these diagenetic modifications vary across different facies belts and their implications for hydrocarbon storage and flow capacity. Ultimately, the findings will provide a predictive framework for reservoir characterization in carbonate sequences, aiding in the exploration and development of analogous reservoirs in the region.

2. Geological setting and stratigraphy

The Upper Cretaceous sedimentary sequences within the Arabian Plate and the Zagros Basin are notable for their abundant hydrocarbon resources, which possess significant economic importance (Alipour, 2024; Alsharhan, 2014; Hollis, 2011; Tavakoli and Barfizadeh, 2024). The Cenomanian–Turonian interval of the Late Cretaceous was characterized by intense tectonic activity along the northeastern margin of the Arabian Plate, including the Zagros Basin (Moghadam and Stern, 2021; Navidtalab et al., 2024; Simmons et al., 2007). The Abadan Plain, situated southwest of the Zagros Fold-Thrust Belt, is considered as a foredeep basin flanked by the Dezful Embayment to the north and east, with extensions into Iraq and the Persian Gulf (AbdollahiFard et al., 2019). Structurally, this basin occupies a transitional zone between the Arabian Plate and the Dezful Embayment/Zagros Fold-Thrust Belt, exhibiting features indicative of both regions (AbdollahiFard et al., 2006; Atashbari et al., 2018).

The Cretaceous period was marked by the highest eustatic sea levels, leading to the extensive development of shallow-marine carbonate platforms along continental plate margins, including the Arabian Plate (Bagherpour et al., 2021; Mehrabi and Rahimpour-Bonab, 2014; Simmons et al., 2007). It is also recognized as a globally warm period, particularly evident in the Middle East (Abdollahi et al., 2024; Huber et al., 2002; Mehrabi et al., 2015a). During the Late Cretaceous, the northeastern margin of the Arabian Plate, encompassing the Zagros Basin in Iran, was situated near the Equator, approximately between 0° and 5° north (Scotese, 2021; Sharland et al., 2004). Consequently, the depositional environment in the region likely experienced a warm, humid tropical climate characterized by intense rainfall (Burgener et al., 2023; Hay, 2008; Keller et al., 2008). The tectonic evolution of the Zagros Basin, shaped by a significant transition from an extensional (Permian–Cenomanian) to a compressional (post-Turonian) regime due to the closure of the Neo-Tethys Ocean, profoundly impacted the diagenetic history and reservoir properties of the Sarvak Formation and its equivalents across the Middle East (Hollis, 2011; Mehrabi et al., 2023a, b, c and 2024; Yahyaei et al., 2025).

The Sarvak Formation is primarily composed of argillaceous and dolomitic limestones and constitutes part of the Bangestan Group reservoirs (Rahimpour-Bonab et al., 2012a). At its type section, the formation conformably overlies the Kazhdumi Formation with a transitional contact, while its upper boundary with the shale and marl layers of the Gurpi Formation is distinctly sharp (Mohseni and Javanmard, 2020; Motiei, 1993). The Bangestan Group exhibits significant lateral variations in thickness and facies distribution, influenced by the presence of paleohighs and troughs (Bagherpour et al., 2021; Mehrabi et al., 2015b; Navidtalab et al., 2019, 2024). Stratigraphically, the Sarvak Formation is equivalent to the Rumaila, Khatiyah, and Mishrif formations in the UAE, Iraq, and Qatar, respectively, and to the Natih Formation in Oman (Alsharhan et al., 2014).

During the Cenomanian–Turonian (C–T) interval, the Arabian Platform and Zagros Basin underwent three major phases of emergence, resulting in the formation of disconformities known as mid-Cenomanian disconformity (mC-ES), Cenomanian–Turonian boundary disconformity (CT-ES) and mid-Turonian disconformity (mT-ES) (see Mehrabi et al., 2022a, b; Simmons et al., 2025). These disconformities and their associated diagenetic features significantly influenced the reservoir properties of the Sarvak Formation (Abbasi et al., 2024; Hajikazemi et al., 2017; Mehrabi, 2023; Taghavi et al., 2006). Meteoric dissolution (karstification) beneath paleoexposure surfaces played a critical role in enhancing porosity and permeability through the development of diverse pore systems (Foroshani et al., 2023; van Buchem et al., 2011). In the Abadan Plain, the study area, the Sarvak Formation is separated from the overlying Ilam Formation by a thin-bedded argillaceous–shaly limestone unit known as the Laffan Formation, which has a thickness of approximately 10–15 m (Atashbari et al., 2018).

3. Data and methods

This study examines the Sarvak Formation utilizing data from two wells (coded as A and B) in an oil field located within the Abadan Plain (Fig. 1). Reservoir characterization was performed through petrographic analysis of 369 m of drilled cores (269 m in well-A and 100 m in well-B), 1463 core-plugs (1076 samples in well-A and 387 samples in well-B) and 1685 thin sections (1220 samples in well-A and 465 samples in well-B) and the evaluation of petrophysical wireline logs, including gamma-ray (GR), bulk density (RHOB), sonic (DT), and neutron porosity (NPHI) measurements. Microfacies and diagenetic attributes were assessed,

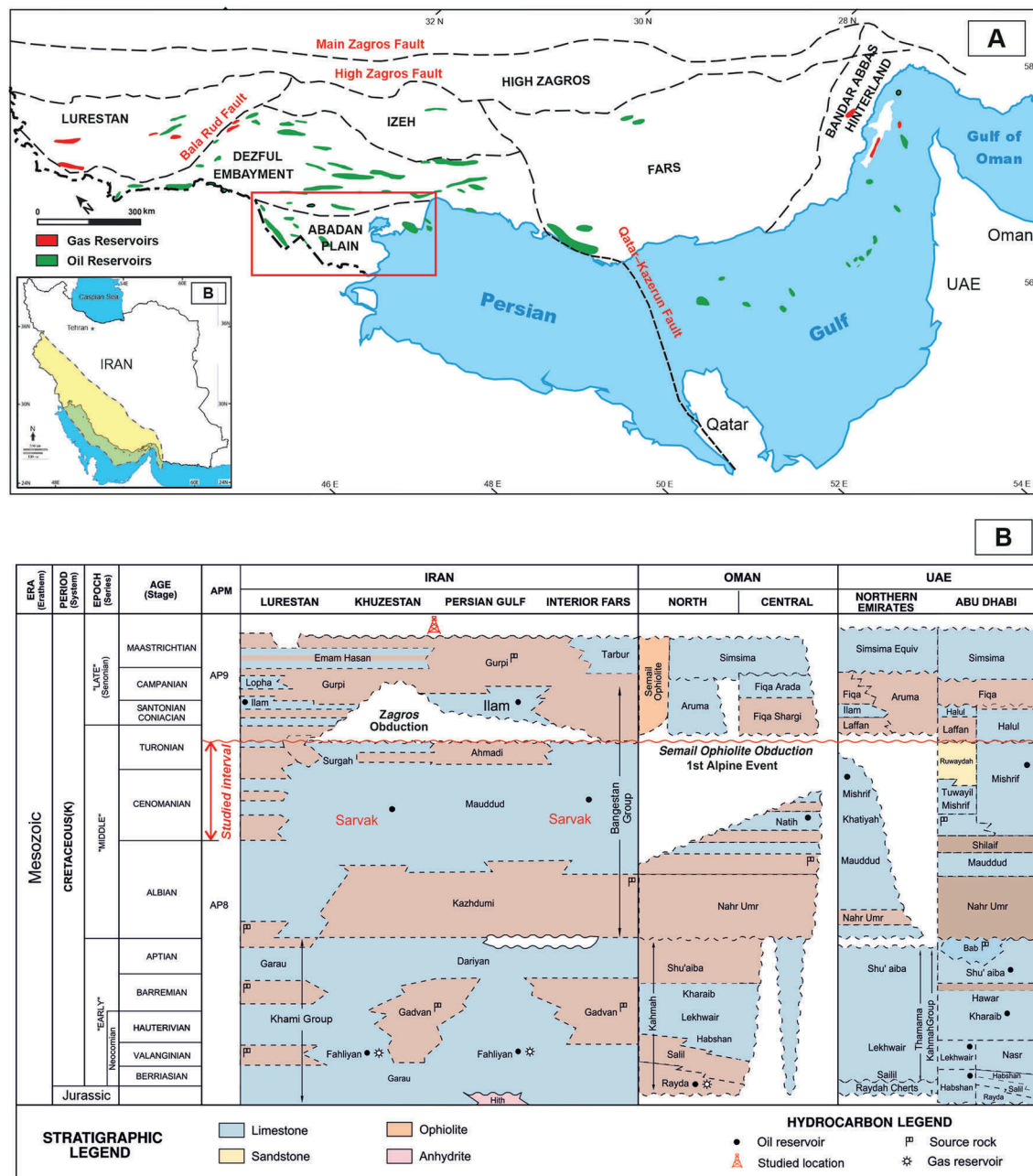


Fig. 1. (A) Location map of the Zagros Basin in the southwestern Iran and the Abadan Plain, as the targeted area of this study (Esrafil-Dizaji and Rahimpour-Bonab, 2019). (B) Stratigraphic column of the Cretaceous rocks in the Zagros region and neighboring countries (adapted with some modifications from petroleum geo-service, 2001; <http://www.pgs.com>).

and depositional environments were interpreted using petrographic analyses of whole cores, core plugs and thin sections. Rock texture classification followed Dunham's scheme (Dunham, 1962) and was applied to interpret depositional settings (Flügel, 2013). Dolomite types were characterized based on crystal morphology and size, using the classification frameworks of Sibley and Gregg (1987) and Warren (2000).

A transgressive-regressive (T-R) sequence stratigraphic approach was applied to delineate depositional sequences (Catuneanu et al., 2011; Embry, 2002; Embry and Johannessen, 2017). Effective helium porosity, determined using an ultra-porosimeter with helium injection, air permeability measured via an ultrapermeameter following Darcy's Law, and grain density were evaluated on 907 core plugs.

To further analyze reservoir properties, an automated reservoir zonation approach was applied to delineate hydraulic flow units (HFUs) (Mehrabi et al., 2019; Ghasemi et al., 2022; Kakemem et al., 2023; Jafarian et al., 2024, 2025). This method integrated the reservoir quality index (RQI) and Flow Zone Indicator (FZI) approaches proposed by Amaefule et al. (1993), along with the pore-throat radius (R_{35}) method introduced by Gunter et al. (1997).

The RQI method is based on the relationship between permeability and porosity and is calculated as (equation (1)):

$$RQI = 0.0314 \times \sqrt{\frac{k}{\phi}} \quad (1)$$

where k represents permeability (mD) and ϕ is porosity.

To normalize porosity effects, the pore-to-grain volume ratio Φ_z is computed as (equation (2)):

$$\Phi_z = \frac{\Phi_e}{1 - \Phi_e} \quad (2)$$

From these, the Flow Zone Indicator (FZI) is determined using (equation (3)):

$$FZI = \frac{RQI}{\Phi_z} \quad (3)$$

In addition, the pore-throat radius (R_{35} ; equation (4)), which is a key parameter in Gunter's method, was determined using Winland's equation (Kolodzie Jr, 1980):

$$\log(R_{35}) = 0.732 + 0.588 \log(K) - 0.864 \log(\phi) \quad (4)$$

To optimize hydraulic flow unit (HFU) classification, an automated clustering approach was applied. The k-means clustering algorithm was used to classify FZI and R_{35} values, while the Elbow method was implemented to determine the optimal number of clusters. This approach aligns with classification frameworks for reservoir quality assessment established by Ahr (2008) and Nabawy and El Sharawy (2018).

To further refine zonation, the Stratigraphic Modified Lorenz Plot (SMLP) technique (Gunter et al., 1997) was utilized. Lorenz reservoir zonation proposed a method of reservoir zonation that incorporates porosity and permeability data to calculate the storage capacity (PhiH) and flow capacity (KH) (equations (5) and (6)):

$$KH_{cum} = K_1 (h_1 - h_0) / Kh_{total} + K_2 (h_2 - h_1) / Kh_{total} + \dots + K_n (h_n - h_{n-1}) / Kh_{total} \quad (5)$$

$$\Phi H_{cum} = \Phi_1 (h_1 - h_0) / \Phi h_{total} + \Phi_2 (h_2 - h_1) / \Phi h_{total} + \dots + \Phi_n (h_n - h_{n-1}) / \Phi h_{total} \quad (6)$$

In the above equations, (h) represents the depth difference (thickness) in meters, (K) denotes permeability in millidarcies, and (ϕ) represents porosity as a percentage. The Pruned Exact Linear Time (PELT) algorithm (Killick et al., 2012) was applied to detect abrupt changes in SMLP slopes, ensuring an objective and data-driven HFU segmentation. This workflow follows recent advancements by Ghasemi et al. (2022) and Kakemem et al. (2023), significantly reducing uncertainty in reservoir zonation while enhancing the accuracy of hydraulic unit delineation.

4. Results

4.1. Microfacies

A detailed facies analysis of the Sarvak Formation has led to the identification of eight distinct microfacies, designated as MF-1 through 8. These microfacies collectively represent a depositional spectrum characteristic of a carbonate ramp system, ranging from shallow inner-platform settings to deeper open-marine environments. The key sedimentological and paleontological characteristics of each microfacies are summarized in Table 1. Microscopic images of the microfacies are shown in Fig. 2.

4.1.1. MF1: planktonic foraminifer microbioclast mudstone to wackestone

This microfacies displays mud-supported textures (mudstone and wackestone) and is distinguished by the presence of planktonic foraminifera (e.g., *Globigerinoides*, *Hedbergella*, and *Rotalipora*), oligosteginids, and a varied assemblage of bioclasts, including echinoderms, rudists, bivalves, sponge spicules,

ostracods, and occasional small benthic foraminifera (e.g., *Rotalia*). Non-skeletal components such as peloids are also observed (Fig. 2). The bioclasts are primarily silt-sized, with echinoderm fragments being notably prevalent.

This microfacies aligns with RMF9 as described by Flügel (2013). The depositional setting is inferred to be a deep marine environment within a carbonate platform, supported by the fine-grained texture, poor sorting, mud-dominated fabric, and the prevalence of planktonic foraminifera. The predominance of planktonic organisms, along with the limited occurrence of benthic foraminifera, indicates deposition in an outer ramp setting below the storm wave base (SWB) (Flügel, 2013).

4.1.2. MF2: foraminifera bioclastic wackestone to packstone

This microfacies displays a range of textures, transitioning from mud-dominated to grain-supported (wackestone to packstone), and is characterized by a diverse assemblage of both large and small benthic foraminifera (e.g., *Textularia* and *Rotalia*), planktonic foraminifera, rudists, bivalves, echinoderms, algae, and ostracods (Fig. 2). Non-skeletal components, including peloids and occasional intraclasts, are also present. Grain sizes vary significantly, from silt to gravel, and the microfacies contains a mix of benthic and planktonic organisms. Most bioclasts show evidence of considerable abrasion.

This microfacies corresponds to RMF3 as defined by Flügel (2013). Given its association with open marine facies and the observed characteristics, the depositional environment is interpreted as a middle ramp setting (Flügel, 2013).

4.1.3. MF3: benthic foraminifer bioclast (echinoids) wackestone

This microfacies is distinguished by a mud-supported texture (wackestone), with skeletal fragments and benthic foraminifera representing the primary allochems (Fig. 2). The benthic foraminifera include *Textularid* sp., *Dictyoconus pachymarginalis*, and *Orbitolina* sp., while skeletal debris consists of echinoderms, rudists, dasyclad algae, and bivalves. Non-skeletal components, such as intraclasts and peloids, are present, with oligosteginids and sponge spicules occurring as minor constituents (Fig. 2).

The limited presence of planktonic foraminifera, alongside the abundance of benthic foraminifera and large fragments of rudists and echinoderms, indicates deposition in a shallower environment relative to the other microfacies (i.e., MF-1 and MF-2). This microfacies correlates with RMF-7 (bioclastic wackestones and packstones with abraded skeletal grains), which is interpreted to represent a middle ramp setting (Flügel, 2013).

4.1.4. MF4: bioclastic grainstone

This grain-supported microfacies is predominantly composed of bioclasts, including rudists, echinoderms, bivalves, and algal fragments, with subordinate components such as small benthic foraminifera and peloids (Fig. 2). The allochems exhibit a calcarenite grain size and are well-sorted. A defining feature of this microfacies is the prevalence of highly abraded bioclasts and indications of early (marine) cementation (Fig. 2).

The grain-dominated texture points to deposition under high-energy conditions. The dominance of bioclasts over benthic foraminifera and peloids, along with the high degree of sorting and extensive isopachous cementation, suggests deposition in shoal setting, around the fair-weather wave base (FWWB). This microfacies aligns with RMF-26 (Bioclastic grainstone/packstone with diverse skeletal grains) in the standard microfacies classification for ramps (Flügel, 2013).

4.1.5. MF5: bioclast benthic foraminifera packstone to grainstone

The key distinguishing features of this microfacies compared to MF-4 (bioclastic grainstone) are the predominance of benthic

Table 1

Summary of microfacies characteristics of the Sarvak Formation in studied field, Abadan Plain.

Facies Association		Microfacies Name	Lithology	Allochems		Depositional Setting
				Skeletal Allochems	Non-Skeletal Allochems	
Outer Ramp	Deep Open Marine	MF-1: Planktonic Foraminifera microbioclast Wackestone	(Dolomitic) Limestone	planktonic foraminifera, oligosteginids, echinoderm debris	fine peloids	Outer Ramp
Middle Ramp	Shallow Open Marine	MF-2: Foraminifera (B&P) bioclast Wackestone to Packstone	(Dolomitic) Limestone	planktonic and small benthic foraminifera, echinoderms, bivalves, rudists, red algae, and bryozoan fragments, and oligosteginids	fine peloids	Middle Ramp
Inner Ramp	Shoal	MF-3: Benthic foraminifera bioclast (echinoids) Wackestone	(Dolomitic) Limestone	whole fossils of echinoderms, bivalves, red algae and bryozoans, foraminifera (both benthic and planktonic)	peloids, intraclasts	Middle Ramp
		MF-4: Bioclastic Grainstone	Limestone	rudist debris, echinoderms, and bivalves	–	Inner Ramp-Shoal (Seaward)
		MF-5: Bioclast benthic foraminifera Packstone to Grainstone	Limestone	rudist debris (well sorted and rounded), benthic foraminifera, green algae intraclasts	–	Inner Ramp-Shoal (Central)
		MF-6: Benthic foraminifera peloidal Packstone	Limestone	benthic foraminifera, shell fragments (largely rudists and bivalve debris)	Peloids, intraclasts	Inner Ramp-Shoal (Leeward)
	Reef	MF-7: Bioclast (rudist & coral) Rudstone/Floatstone	Limestone	rudist debris and green to red algae fragments, corals, echinoderms, and benthic foraminifera	–	Inner Ramp-Reef (Talus)
	Lagoon	MF-8: Bioturbated benthic foraminifera peloidal Mudstone to Wackestone	(Dolomitic) Limestone	benthic foraminifera, rudist and green algae fragments	Peloids	Inner Ramp-Lagoon

foraminifera as the primary allochems and the presence of a lime mud matrix, ranging in frequency from <5% to 40%. The benthic foraminifera include *Nezzazata* sp., *Dicyclina schlumbergeri*, *Nezzazatinella picardi*, *Nummoloculina* sp., and *Textularids* sp., while skeletal fragments are mainly composed of rudists, green algae, echinoderms, and other bivalves (Fig. 2). No significant sedimentary structures are observed in this microfacies.

The grain-dominated textures indicate deposition under high-energy conditions. However, the allochems are predominantly composed of shallow-marine (lagoonal) index fauna, such as hyaline benthic foraminifera, green algae, and rudists. The variable presence of lime mud as a matrix suggests a lower energy regime compared to MF-4. This microfacies aligns with RMF27 of Flügel (2013), which is characteristic of high-energy, central-shoal environments.

4.1.6. MF6: benthic foraminifera peloidal wackestone to packstone

This microfacies is distinguished by the predominance of peloids and small benthic foraminifera, including *Nezzazata* sp., *Dicyclina schlumbergeri*, *Nezzazatinella picardi*, *Nummoloculina* sp., and *Textularids* sp. Other components consist of rudists, bivalves, and green algae debris. Peloids are particularly abundant and represent the primary allochems in most samples of this microfacies (Fig. 2). Evidence of bioturbation and micritization is also observed. The microfacies display a range of textures, from mud-to grain-supported.

In contrast to MF-4 and MF-5, the mud-to grain-dominated textures of this microfacies suggest deposition under relatively lower energy conditions. The absence of fully preserved shells, combined with the abundance of well-rounded, micritized bioclasts and intraclasts, points to reworking (under high-energy conditions) and bioerosion in an environment likely situated around the fair-weather wave base (Korbar et al., 2001). This microfacies corresponds to RMF13 of Flügel (2013), which is characteristic of leeward-shoal environments with variable energy levels.

4.1.7. MF7: bioclast (rudist & coral) rudstone/floatstone

This microfacies is characterized by the prominent presence of rudists, corals, and green algae (Fig. 2). Lagoonal benthic foraminifera, such as *Nezzazata* sp. and miliolids, are also observed, along with occasional peloids and intraclasts as minor components. Large (>2 mm in diameter) fragments of reef-building organisms, including rudists, corals, and algae, contribute to the mud-to grain-dominated textures, classified as floatstone and rudstone based on the textural classification scheme of Embry and Klovan (1971).

This microfacies aligns with RMF15 of Flügel (2013). In some cases, the occurrence of rudist rudstones and floatstones (on a macroscopic scale) is interpreted as taluses of rudist patch-reefs (Di Stefano and Ruberti, 2000). Rudist colonies typically flourished in the shallower regions of the ramp (i.e., inner ramp) above the fair-weather wave base (FWWB) (Cestari and Sartorio, 1995). These microfacies are interpreted as talus deposits that formed around rudist-algal patch-reefs (e.g., Aqrabi et al., 2010; Esrafil-Dizaji et al., 2015; Sadooni, 2005). In this study, these facies represent rudist patch-reefs, with rudstones reflecting in-place bioaccumulation in a low-relief ramp setting.

4.1.8. MF8: bioturbated benthic foraminifer peloidal mudstone to wackestone

This mud-supported microfacies is primarily defined by the abundance of large benthic foraminifera, including *Nezzazata* sp., alveolinids, *Dicyclina* sp., and miliolids, alongside subordinate green algae, rudists, and gastropod fragments (Fig. 2). Peloids are the only non-skeletal components present. Bioturbation is a prominent sedimentary feature observed in this microfacies (Fig. 2).

The high proportion of micrite, reflected in wackestone and mudstone textures, suggests deposition in a low-energy environment. Based on the fossil assemblage and sedimentary textures, a low-energy, shallow marine setting is inferred. The restricted faunal diversity further supports limited water circulation, consistent with a lagoonal environment (Flügel, 2013). This

microfacies corresponds to RMF16 of Flügel (2013), which is characteristic of low-energy lagoon settings.

4.2. Diagenesis

The Sarvak Formation exhibits a wide range of diagenetic alterations, including dissolution (karstification), brecciation, multiple phases of calcite cementation, dolomitization, recrystallization, micritization, pyritization, silicification,

compaction, and fracturing (Figs. 3 and 4).

Brecciation is present in paleokarst zones and is associated with meteoric diagenesis (Fig. 3A–C; Fig. 4B), while paleosol horizons are identified by the presence of microcrystalline calcite, rhizoliths, iron oxide staining, and silicification indicating sub-aerial exposure (Fig. 3B; Fig. 4C).

Dissolution is observed as vuggy, moldic, and microporosity, primarily in grain-supported microfacies and patch-reef facies (Fig. 3K and L; Fig. 4A).

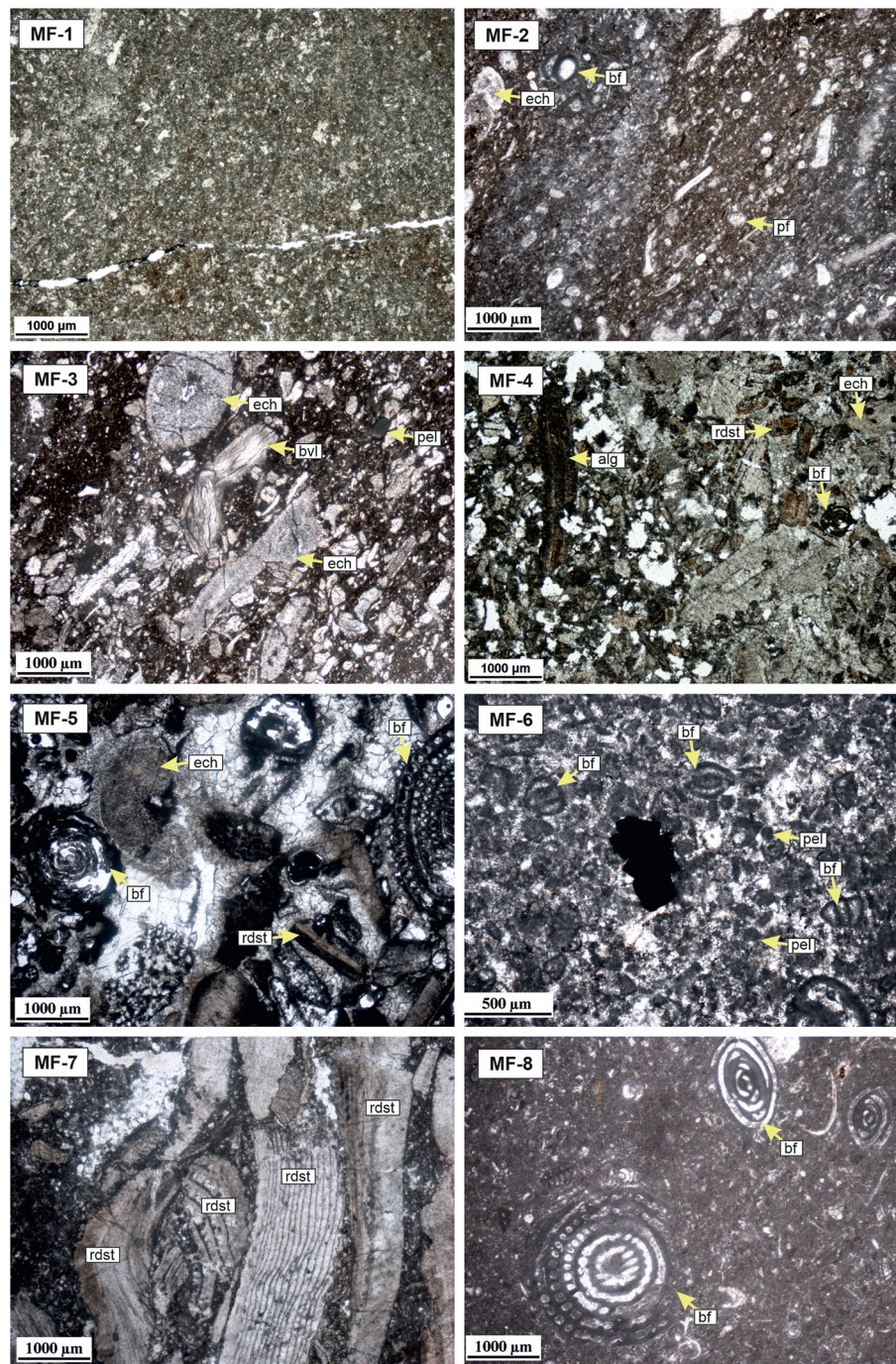


Fig. 2. Photomicrographs of microfacies of the Sarvak Formation in the studied wells. MF-1: Planktonic Foraminifera micro bioclast Wackestone, MF-2: Foraminifera bioclast Wackestone to Packstone, MF-3: Benthic foraminifera bioclast (echinoids) Wackestone, MF-4: Bioclastic Grainstone, MF-5: Bioclast benthic foraminifera Packstone to Grainstone, MF-6: Benthic foraminifera peloidal Packstone, MF-7: Bioclast (rudist, coral) Rudstone/Floatstone, MF-8: Bioturbated benthic foraminifera peloidal Mudstone to Wackestone. Abbreviations – ech: echinoderm, bf: benthic foraminifera, pf: planktic foraminifera, bvl: bivalve, pel: peloid, alg: algae, rdst: rudist.

The Sarvak Formation contains multiple generations of calcite cements, including isopachous, drusy, blocky, equant, and syntaxial overgrowth cements (Fig. 3F; Fig. 4D–G). Isopachous cement is found in marine-influenced facies, while drusy and blocky cements are common in burial diagenetic environments. Syntaxial overgrowth cement is observed around echinoderm fragments in grain-supported facies.

Mechanical compaction is evident in grain-supported facies, such as shoal and rudist-dominated facies, where grain deformation and point contacts are visible (Fig. 4H). Chemical compaction is present in mud-supported facies as solution seams and stylolites, indicating pressure dissolution at greater burial depths (Fig. 3G–J; Fig. 4I and J).

Dolomitization is recognized in mud-supported facies and is observed as partial to complete replacement of the original carbonate matrix along the solution seams and stylolites (Fig. 3J; Fig. 4J and K). Intercrystalline dolomite porosity is present in dolomitized wackestones and packstones, while saddle dolomite is occasionally observed in fractured zones.

Fractures in the Sarvak Formation occur as open, partially filled, or completely cemented fractures and are more frequent in mud-supported facies, where they enhance secondary porosity (Fig. 3D–F; Fig. 4L). Some fractures are associated with stylolites, suggesting a link to chemical compaction and burial diagenesis.

The extent and intensity of these diagenetic processes vary based on lithology, texture, and microfacies, as presented in Section 4.4.

4.3. Sequence stratigraphy

The Sarvak Formation is characterized by two third-order depositional sequences, designated as Sv_Cen. and Sv_Tur. (Fig. 5). These sequences reflect cyclic variations in relative sea level and are bounded by key stratigraphic surfaces that facilitate regional correlation. Two prominent paleoexposure surfaces, referred to as CT-ES (Cenomanian–Turonian boundary exposure surface) and mT-ES (middle Turonian exposure surface), have been identified as type-I sequence boundaries (SB). These surfaces serve as significant regional stratigraphic markers, aiding in the correlation of depositional sequences across the study area.

The stratigraphic architecture of the Sarvak Formation exhibits a systematic facies distribution within each depositional sequence. The transgressive systems tracts (TST) are primarily composed of open-marine facies, including deposits characteristic of the middle to outer ramp settings, reflecting deepening conditions associated with rising relative sea levels (Fig. 5). In contrast, the regressive systems tracts (RST) display a vertical stacking pattern dominated by lagoonal, patch-reef, and shoal facies, indicative of shallowing conditions during sea-level fall and progradation of the carbonate platform (Fig. 5).

Paleoexposure-related diagenetic modifications, such as dissolution, meteoric cementation, and paleosol development, serve as reliable indicators for the identification of sequence boundaries within the Sarvak Formation (i.e., CT-ES and mT-ES). Additionally, the deepest marine facies within each sequence, representing the point of maximum transgression, are interpreted as maximum flooding surfaces (MFS). These surfaces mark the transition from deepening to shallowing conditions and are crucial for sequence stratigraphic interpretation (Fig. 5).

4.4. Frequency analysis

The frequency of all diagenetic processes was calculated across different lithologies (limestone, dolostone, limy dolostone, and dolomitic limestone), texture clusters (mud-supported, grain-

supported, framework-supported, and crystalline), and eight microfacies (MF-1 to MF-8) to assess their impact on rock properties. Cross-tabulation tables were used to compare diagenetic alterations with lithology, texture, and microfacies, while bar charts were generated to visualize the distribution of cementation, dissolution, compaction, dolomitization, and fractures (open, partially filled, and completely filled) across different rock types. Additionally, the correlation between porosity types and diagenetic features was analyzed to evaluate their influence on reservoir quality.

4.4.1. Diagenesis vs. lithology

Lithology (mineralogy) significantly influences diagenetic processes, which in turn control the reservoir quality of the Sarvak Formation. The four lithologies analyzed—dolomitic limestone, dolostone, limestone, and limy dolostone—exhibit different responses to cementation, dissolution, compaction, and fracturing (Fig. 6).

Cementation and Dissolution: Cementation varies among lithologies, with dolostone generally showing lower cementation due to the preferential dissolution of unstable carbonate components. In contrast, limestone exhibits higher cementation, which reduces porosity. Dolomitic limestone and limy dolostone display moderate cementation levels. Dissolution, a key process for secondary porosity development, is moderate in dolostone (Fig. 6A).

Compaction: Mechanical compaction is most pronounced in fine-grained limestones, where pressure dissolution features such as stylolites and solution seams are well-developed. Dolostone, due to its recrystallization and interlocking crystal fabric, shows lower compaction compared to limestone. When a rock undergoes dolomitization, the difference in resistance between grains decreases, making the rock more homogeneous. As a result, chemical compaction appears in the form of solution seams (Fig. 6B).

Pore Types: Dolostone has a high proportion of intercrystalline porosity due to recrystallization, which enhances permeability. Limestone shows a greater dominance of moldic, vuggy, and interparticle porosity, suggesting the dissolution of aragonitic components such as mollusk shells. Interparticle porosity is relatively low in some lithologies, implying that early cementation reduced primary porosity (Fig. 6C).

Fracturing: The sum of open, partially filled, and completely filled fractures is highest in limestone, suggesting that brittle deformation enhances permeability in this lithology. In contrast, limy dolostone and dolostone show lower fracture intensity, likely due to their higher ductility and susceptibility to compaction-related deformation (Fig. 6D).

4.4.2. Diagenesis vs. texture

The diagenetic evolution of carbonate rocks is strongly controlled by texture, which dictates pore structure, fluid flow, and susceptibility to diagenetic alterations. The four texture clusters analyzed are: Cluster 1: Mudstone and Wackestone (mud-supported), Cluster 2: Packstone and Grainstone (grain-supported), Cluster 3: Rudstone, Boundstone, and Floatstone (patch-reef facies), and Cluster 4: Crystalline (dolomitized and/or recrystallized).

Cementation: Grain-supported textures (Cluster 2) show the highest cementation due to their greater primary porosity, which facilitates early calcite precipitation. Mud-supported textures (Cluster 1) exhibit lower cementation, indicating that less pore space was initially available for cement precipitation. Patch-reef facies (Cluster 3) display moderate cementation, likely controlled by their framework nature, which can either enhance or restrict cementation depending on syndimentary binding (Fig. 7A).

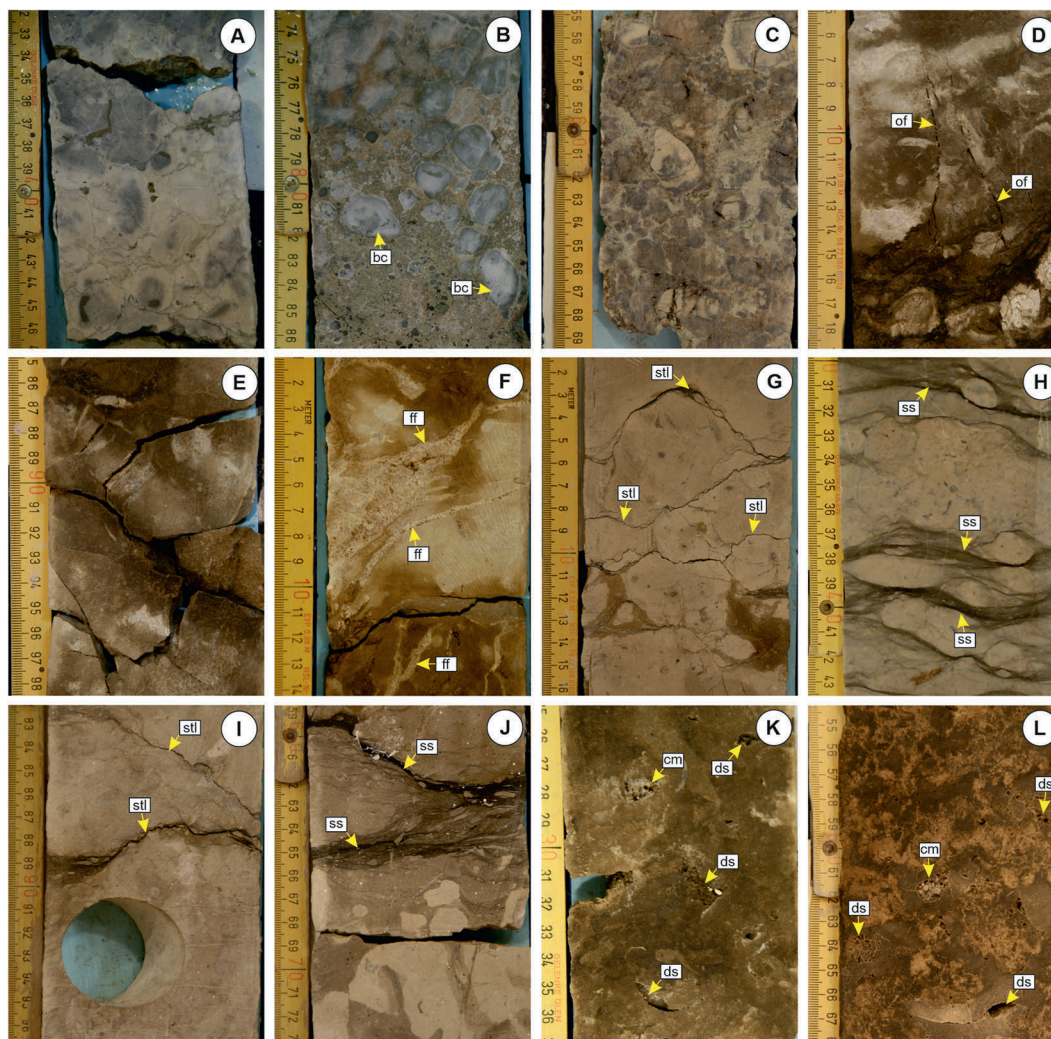


Fig. 3. Core photos of diagenetic features of the Sarvak Formation in the Zagros Basin. A: brecciation, B: brecciation and paleosol, C: brecciation, D: partially filled fracture, E: open fracture, F: completely cemented fracture, G: chemical compaction (stylolite), H: chemical compaction (solution seams), I: chemical compaction (stylolite), J: solution seams and stylolite-related dolomitization, K-L: dissolution vugs, moldic porosity and microporosity. Abbreviations – bc: brecciation, of: open fracture, ff: filled fracture, stl: stylolite, ss: solution seam, cm: cement, ds: dissolution.

Dissolution: Dissolution is most significant in Cluster 3 (rudstone, boundstone, floatstone), where framework porosity allows for extensive fluid interaction. Cluster 2 (grain-supported facies) also shows substantial dissolution, primarily due to the selective leaching of aragonitic grains. Cluster 4 (crystalline carbonate) has the lowest dissolution, indicating that dolomitization stabilized the rock fabric against later dissolution (Fig. 7B).

Dolomitization: Cluster 4 (crystalline carbonate) exhibits the highest degree of dolomitization, supporting the idea that certain depositional environments were prone to Mg-rich fluid influx. Cluster 1 shows moderate dolomitization, while Clusters 2 and 3 are less affected, suggesting that dolomitization preferentially occurs in fine-grained facies (Fig. 7C).

Compaction: Mud-supported textures (Cluster 1) are more affected by mechanical compaction, leading to a greater abundance of stylolites and pressure-solution features. In contrast, grain-supported textures (Clusters 2 and 3) show less compaction. Cluster 4 (crystalline carbonate) exhibits minimal compaction due to the reduced difference in resistance between grains and the appearance of chemical compaction in the form of solution seams (Fig. 7D).

Fracturing: Fracturing is highest in mud-supported textures (Cluster 1), while grain-supported textures (Cluster 2) show moderate levels. Crystalline carbonate (Cluster 4) has the lowest amount of fracturing (Fig. 7E).

4.4.3. Diagenesis vs. microfacies

Microfacies analysis provides a more refined understanding of diagenetic trends by linking depositional environments to diagenetic modifications. The eight microfacies (MF-1 to MF-8; Table 1) demonstrate distinct diagenetic responses:

Cementation: MF-4 (bioclastic grainstone), MF-5 (packstone to grainstone), and MF-7 (rudist & coral floatstone) exhibit the highest cementation, demonstrate lower fluid interaction rate. In contrast, MF-1 (planktonic foraminifera wackestone) and MF-2 (foraminifera bioclast wackestone to packstone) exhibit the least cementation, reflecting lower porosity retention (Fig. 8A).

Dissolution: MF-4, MF-5, MF-6, and MF-7 exhibit higher dissolution, enhancing vuggy porosity. MF-1, MF-2, MF-3, and MF-8 experience relatively low dissolution, suggesting they were not significantly exposed to meteoric diagenesis (Fig. 8B).

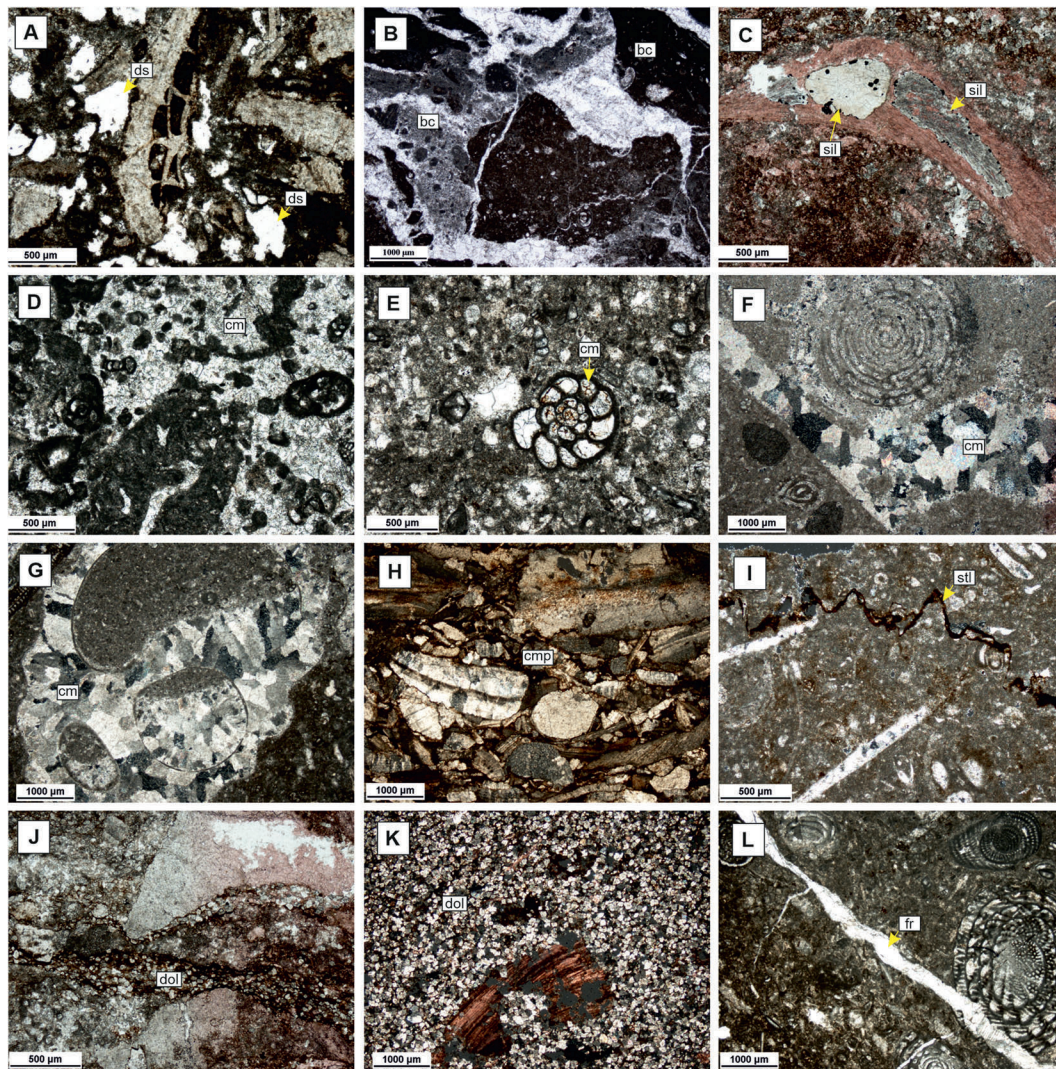


Fig. 4. Photomicrographs of diagenetic features of the Sarvak Formation in the Zagros Basin. A: dissolution vugs, B: brecciation, C: brecciation and paleosol, D: equant calcite cementation, E: drusy calcite cementation, F: blocky cementation, G: syntaxial overgrowth cementation, H: mechanical compaction, I: chemical compaction (solution seams), J–K: stylolite-related dolomitization, L: completely cemented fracture. Abbreviations – bc: brecciation, stl: stylolite, cm: cement, ds: dissolution, sil: silicification, cmp: compaction, fr: fracture, dol: dolomitization.

Dolomitization: MF-1, MF-2, MF-3, and MF-8 are the most dolomitized microfacies, implying that mud-supported facies are more chemically compacted, particularly by stylolite-related dolomitization, which is more common in these facies (Fig. 8C).

Compaction: Fine-grained facies (MF-1, MF-2, MF-3, MF-8) show the highest compaction, with well-developed solution seams. Coarse-grained microfacies (MF-4, MF-5, MF-6, MF-7) experience more stylolite-related compaction due to a greater difference in grain resistance (Fig. 9A).

Pore Types: Vuggy porosity is highest in MF-7 due to the dissolution of rudist and coral frameworks. While microporosity and intercrystalline porosity are significant in MF-1, MF-2, MF-3, and MF-8. Moldic porosity is most common in grain-supported microfacies (MF-4, MF-5, MF-6), reflecting the dissolution of aragonitic bioclasts (Fig. 9B).

Fracturing: Fracturing is highest in MF-8, where mud-supported microfacies are more brittle. MF-4 and MF-5 demonstrate low fracturing due to their grain-supported texture (Fig. 9C).

4.5. Automated reservoir zonation and flow units

A fully automated reservoir zonation approach was applied to the Sarvak Formation. Following this, the RQI vs. Φ_z cross-plot was generated to classify flow zones based on their reservoir quality characteristics (Figs. 10 and 11). Based on the results of the automated reservoir zonation, four hydraulic flow units (HFUs) were identified within the Sarvak Formation (Figs. 10 and 11; Table 2). These HFUs represent distinct petrophysical classes, each exhibiting varying degrees of flow and storage capacities, primarily categorized based on Flow Unit Stratigraphy (FUS) values. The lithological characteristics, microfacies distribution, and petrophysical properties of these units are illustrated in Figs. 12 and 13 for the studied wells A and B, respectively.

HFU 1: This unit represents the intervals with the lowest flow potential, characterized by FUS values below 0.1. It is identified as the least effective reservoir zone, exhibiting the lowest RQI, FZI, and R35 values (Table 2). The average pore volume in this unit is 10.85%, while the permeability averages 2.76mD. The reduced

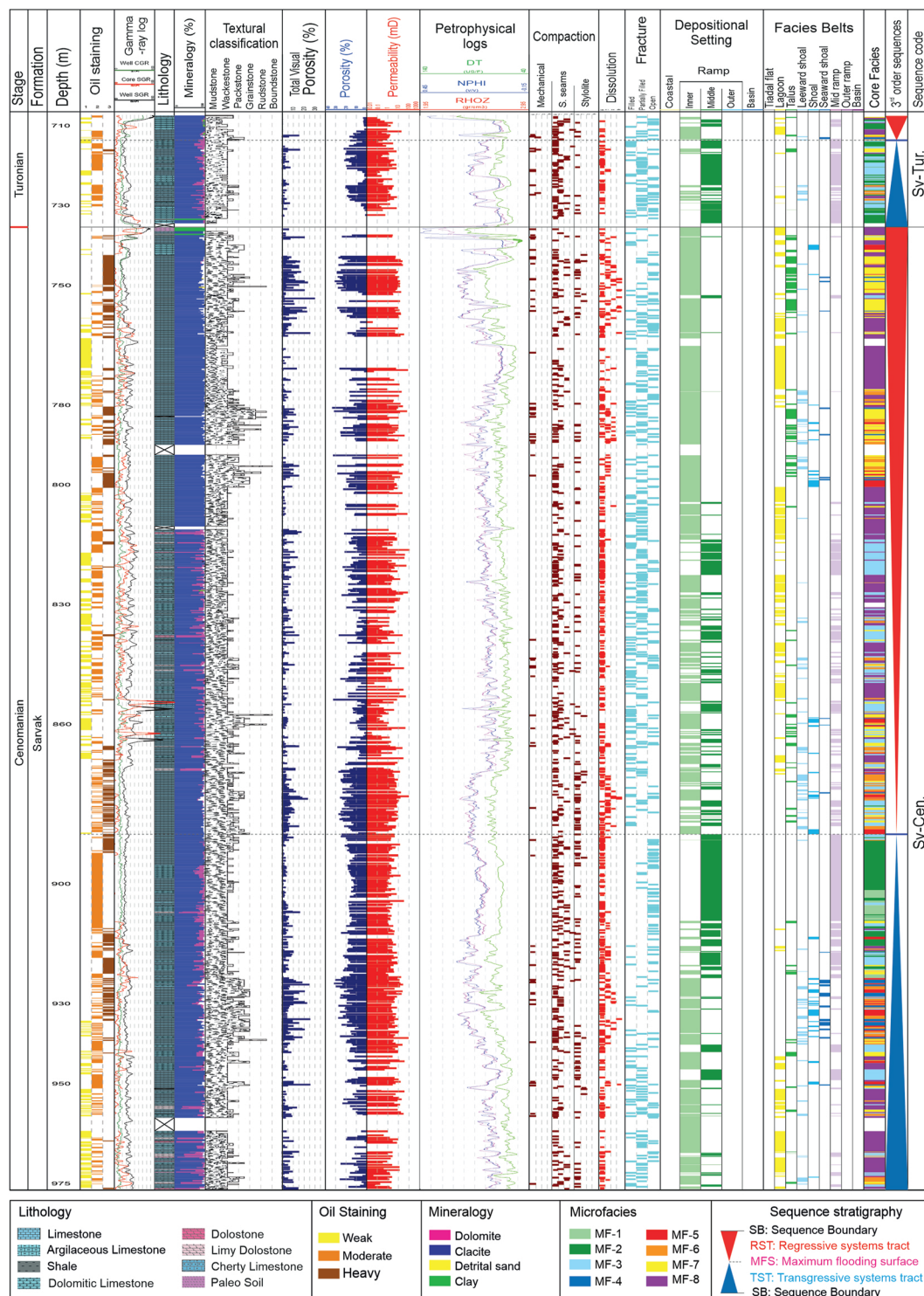


Fig. 5. Sedimentological column of the Sarvak Formation in the studied area, Abadan Plain, Zagros Basin.

storage and flow properties suggest that this unit acts as a baffle or barrier zone, impeding fluid movement within the reservoir (Figs. 12 and 13).

HFU 2: The second hydraulic flow unit consists of intervals with FUS values ranging from 0.1 to 0.4, indicating moderate flow potential. Compared to HFU 1, this unit exhibits higher RQI, FZI, and R35 values, corresponding to improved reservoir quality. The average pore volume is 14.45%, and the average permeability is 10.44mD (Table 2). This unit is classified as a normal-quality

reservoir zone, possessing better flow properties while still exhibiting some heterogeneity in pore connectivity (Figs. 12 and 13).

HFU 3: This unit includes reservoir intervals with FUS values between 0.4 and 0.7, representing a high-quality reservoir with significantly improved flow and storage capacity. The average pore volume in this HFU is 15.95%, while the average permeability reaches 31.35mD (Table 2), reflecting a considerable enhancement in permeability relative to HFU 2. The higher RQI, FZI, and R35

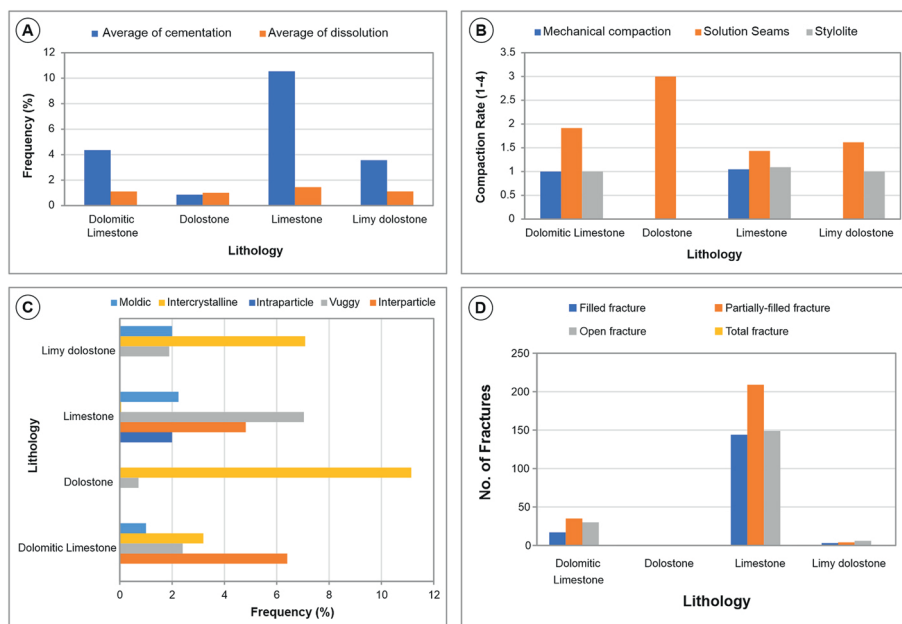


Fig. 6. Frequency diagrams illustrating the association between lithology and diagenetic features in the Sarvak Formation. A: Relationship between lithology and the average intensity of cementation and dissolution processes. B: Variation of compaction features (mechanical, solution seams, stylolites) across lithologies. C: Distribution of pore types (moldic, vuggy, intercrystalline, etc.) across different lithologies. D: Frequency and types of fractures (open, partially-filled, filled) in relation to lithology.

values suggest that HFU 3 plays a crucial role in fluid transmission within the Sarvak Formation (Figs. 12 and 13).

HFU 4: The final hydraulic flow unit comprises the highest reservoir quality intervals, characterized by FUS values exceeding 0.7. This unit demonstrates excellent flow and storage capacity, with the highest RQI, FZI, and R35 values in the formation. The average pore volume is 17.4%, and the average permeability reaches 45.99mD (Table 2), making this HFU the most effective in terms of reservoir productivity. The presence of well-connected pore networks and enhanced permeability structures indicates that HFU 4 represents the best reservoir intervals within the studied wells (Figs. 12 and 13).

The reservoir properties of the Sarvak Formation are fundamentally controlled by diagenetic alterations that significantly modify pore networks and fluid flow characteristics within distinct Hydraulic Flow Units (HFUs). This analysis evaluates reservoir quality variations by systematically integrating microfacies associations, diagenetic modifications, and depositional environment data, with particular emphasis on understanding how diagenetic processes govern porosity-permeability relationships in each HFU.

4.5.1. HFU1: low-quality reservoir zone

This unit exhibits poor reservoir characteristics (FUS: 0–0.1; permeability: ~2.76mD; porosity: ~10.85%). Extensive marine cementation (isopachous and drusy calcite) and compaction have severely reduced porosity through pore-filling cementation and grain collapse. Stylolitization in MF-1 and MF-3 creates flow barriers, while the mud-supported fabric promotes ineffective microporosity, resulting in high heterogeneity and poor fluid connectivity.

4.5.2. HFU2: moderate-quality reservoir zone

With intermediate properties (FUS: 0.1–0.4; permeability: ~10.44mD; porosity: ~14.45%), this dolomitic limestone-dominated unit shows balanced diagenetic effects. Dolomitization enhances intercrystalline porosity in MF-1 to MF-3 and MF-8,

though compaction still restricts pore connectivity. Localized fracturing provides secondary flow paths, creating a mixed porosity system (intercrystalline and microporosity) that supports moderate storage but limited flow capacity.

4.5.3. HFU3: high-quality reservoir zone

This unit demonstrates superior reservoir quality (FUS: 0.4–0.7; permeability: ~31.35mD; porosity: ~15.95%) through effective dolomitization in middle-to outer ramp facies (MF-1 to MF-3) that creates well-connected intercrystalline porosity. Fracture networks associated with stylolites and tectonic deformation in MF-3 and MF-8 significantly enhance permeability by linking isolated pores, resulting in efficient fluid flow systems.

4.5.4. HFU4: excellent-quality reservoir zone

The highest quality reservoir (FUS: >0.7; permeability: ~45.99mD; porosity: ~17.4%) features inner-ramp patch-reef facies (MF-7) with intense dissolution creating vuggy and moldic porosity beneath exposure surfaces. Combined with extensive fracture networks and supplementary dolomitization, this unit develops an optimal pore system integrating vuggy, interparticle, and intercrystalline porosity types that maximize both storage and flow capacity.

5. Discussion

5.1. Depositional model

Microfacies analysis reveals that the Sarvak Formation was deposited across a spectrum of sub-environments, ranging from inner-platform to outer-platform (open marine) settings (Fig. 14). The inner-platform facies consist predominantly of mud-supported and grain-supported lithologies, reflecting deposition in restricted to semi-open marine conditions. The most proximal facies, represented by lagoonal deposits (MF-8), are characterized by mudstone to wackestone textures, indicative of low-energy conditions with limited hydrodynamic activity. Such fine-grained carbonates are

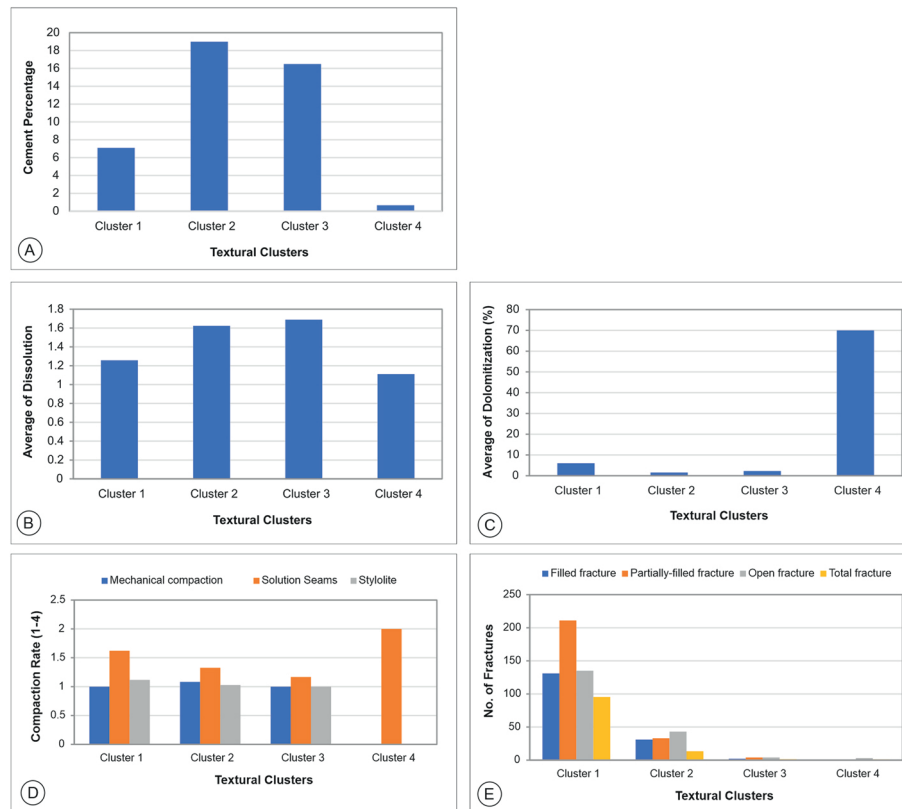


Fig. 7. Frequency diagrams illustrating the relationships between textural clusters and diagenetic processes in the Sarvak Formation. A: Relationship between textural clusters and the percentage of cement. B: Correlation between textural clusters and the average intensity of dissolution. C: Trend of dolomitization across textural clusters. D: Effect of texture on compaction features. E: Distribution of fracture types among textural clusters.

typical of homoclinal ramp systems, where restricted circulation in inner-platform settings facilitates the preservation of micritic sediments (Al-Jabri et al., 2015; Bassi, 2005).

High-energy shoal setting (MF-4 to MF-6), composed of packstone to grainstone textures, signify wave- and current-dominated shallow-platform environments. These facies exhibit extensive grain reworking, a hallmark of carbonate ramp systems in the region (Flügel, 2013; Tucker et al., 2001). Rudist-bearing facies (MF-7), displaying floatstone to rudstone textures, are interpreted as patch-reef deposits (i.e., autochthonous buildups), consistent with homoclinal ramp models (Boix et al., 2023; Esrafil-Dizaji et al., 2015; Steuber and Löser, 2000).

Open-marine facies (MF-1 to MF-3) comprise wackestone to packstone textures, dominated by diverse bioclasts, including echinoderm fragments, benthic- and planktonic foraminifera. These facies suggest deposition in deeper, low-energy outer-ramp environments, where reduced wave action and increased accommodation space prevail (Flügel, 2013). The presence of planktonic foraminifera further indicates periodic water column stratification, marking the transition from shallow to deeper marine conditions (Bernasconi and Pika-Biolzi, 2000). This facies distribution aligns with established carbonate ramp models, where outer-ramp settings are typified by fine-grained, bioclastic-rich sediments (Lubeseder et al., 2009a,b; Flügel et al., 2013).

The proposed ramp-like depositional model for the Sarvak Formation (Fig. 14) is corroborated by regional studies across the Zagros Basin. Investigations in the Izeh and Lurestan areas describe a non-rimmed shelf or distally steepened ramp, with a clear facies transition from inner-platform lagoonal to outer-platform open-marine environments (Asadi Mehmandosti et al., 2013; Esfandiyari

et al., 2023; Moeini et al., 2023). Similarly, studies in the Dezful Embayment and Abadan Plain support a homoclinal ramp model, where lithological variations reflect energy gradients and accommodation space dynamics (Kiani et al., 2022; Mehrabi et al., 2023a, 2023b, 2023c; Flügel, 2013). Comparable ramp features are documented in the Fars and Persian Gulf regions, reinforcing the homoclinal ramp interpretation for the Sarvak Formation (Bagherpour et al., 2021; Gholami Zadeh et al., 2019).

In summary, integrating microfacies data with regional studies robustly supports the interpretation of the Sarvak Formation as a homoclinal carbonate ramp system (Fig. 14). The facies distribution—progressing from lagoonal, high-energy shoal, and patch-reef to open-marine environments—is characteristic of ramp settings in the Zagros Basin (van Buchem et al., 2011). This consistency across the basin underscores the applicability of the proposed depositional model to the studied field.

5.2. Paragenesis

The diagenetic evolution of the Sarvak Formation demonstrates a multifaceted interaction between marine, meteoric, and burial diagenetic processes, each imparting unique changes to the carbonate's textural and petrophysical characteristics (Fig. 15). These distinct diagenetic stages represent the formation's progressive transformation from initial deposition to its current state.

Marine Diagenesis: The earliest diagenetic modifications in the Sarvak Formation principally result from marine diagenesis. This stage features isopachous rim cement development, especially in grain-dominated facies such as those comprising the shoal complex (MF-4 to MF-6) and patch-reef deposits (MF-7). Marine

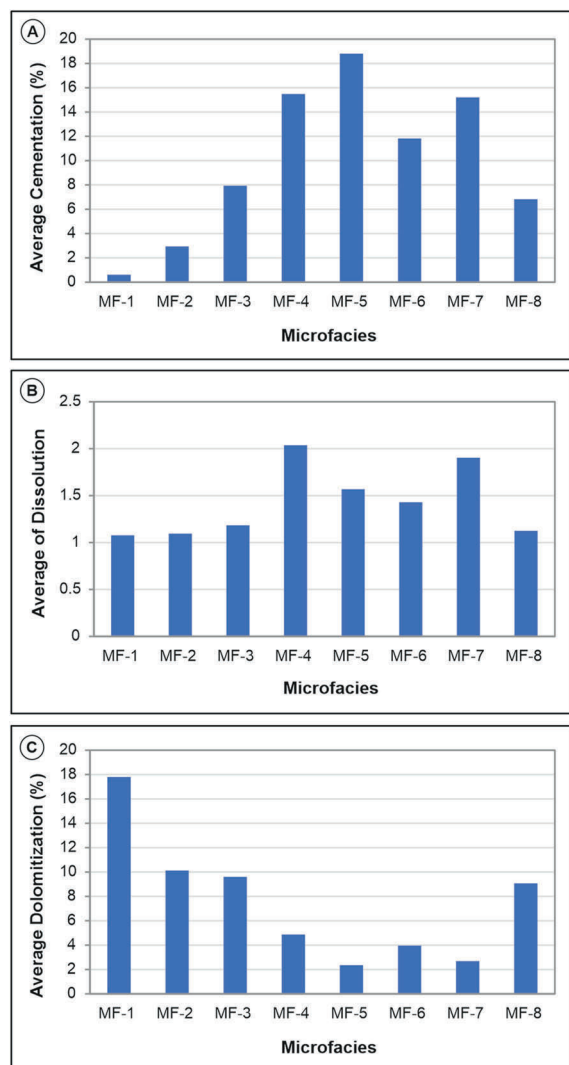


Fig. 8. Frequency diagrams showing the relationships between microfacies and diagenetic features in the Sarvak Formation. A: Distribution of cement percentage across different microfacies types (SMF-1 to SMF-8). B: Variation in average dissolution intensity among the identified microfacies. C: Extent of dolomitization (%) associated with each microfacies category.

cement precipitation reinforced carbonate grains, maintaining the original grainstone and packstone fabric (Lu et al., 2023). This low-temperature cementation process, driven by ion-rich marine pore waters, represents a typical feature of shallow marine environments (Moore and Wade, 2013). Comparable marine cementation patterns have been extensively documented in Sarvak Formation studies throughout the Zagros Basin, particularly in the Izeh and Dezful areas (Abbasi et al., 2024; Foroshani et al., 2023; Rahimpour-Bonab et al., 2012a).

Meteoric Diagenesis: The most substantial diagenetic alterations in the Sarvak Formation stem from meteoric influences. Two separate subaerial exposure events have profoundly affected the carbonates, generated extensive dissolution features and created vuggy and moldic porosity. These modifications are particularly evident in inner-platform facies (MF-8), where initially deposited fine-grained carbonates in restricted lagoonal settings were subsequently transformed during exposure to meteoric waters. The combination of mineral dissolution and precipitation of characteristic meteoric cements (including dog-tooth, pendant, and drusy varieties) has produced the distinctive porosity and cementation

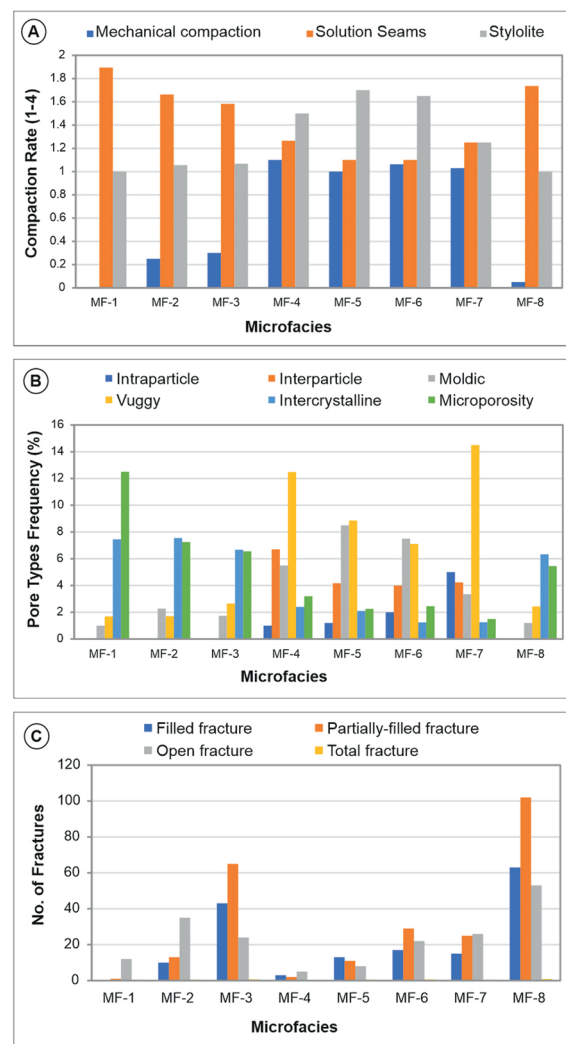


Fig. 9. Frequency diagrams explaining the associations between microfacies and diagenetic features in the Sarvak Formation. A: Degree of mechanical and chemical compaction (solution seams and stylolites) across microfacies types (SMF-1 to SMF-8). B: Frequency distribution of dominant pore types among microfacies. C: Variation in fracture occurrence and type (filled, partially-filled, open) across microfacies categories.

patterns observed (Mehrabi, 2023; Yahyaei et al., 2024). The presence of paleosols, silicification, and chert nodules further confirms extended periods of meteoric influence (Du et al., 2015; Mehrabi and Rahimpour-Bonab, 2014). Similar meteoric diagenetic effects have been reported from investigations in the Abadan Plain (Assadi et al., 2023; Kiani et al., 2022) and Dezful Embayment (Navidtalab et al., 2016, 2024), highlighting their regional importance for porosity development and cement distribution.

Burial Diagenesis: Subsequent to meteoric alterations, burial diagenesis has substantially modified the Sarvak carbonates. This deep diagenetic phase is characterized by blocky and equant cement formation under elevated temperature and pressure conditions (Moore and Wade, 2013). These cements, together with pressure dissolution features like stylolites and solution seams, record the carbonates' response to increasing burial depth. Widespread dolomitization, particularly in deeper sections of outer-platform facies (MF-1 to MF-3), has significantly altered rock properties through magnesium-rich fluid interactions (Mehdipour et al., 2023). Fracture development associated with burial processes has locally enhanced permeability. Numerous studies

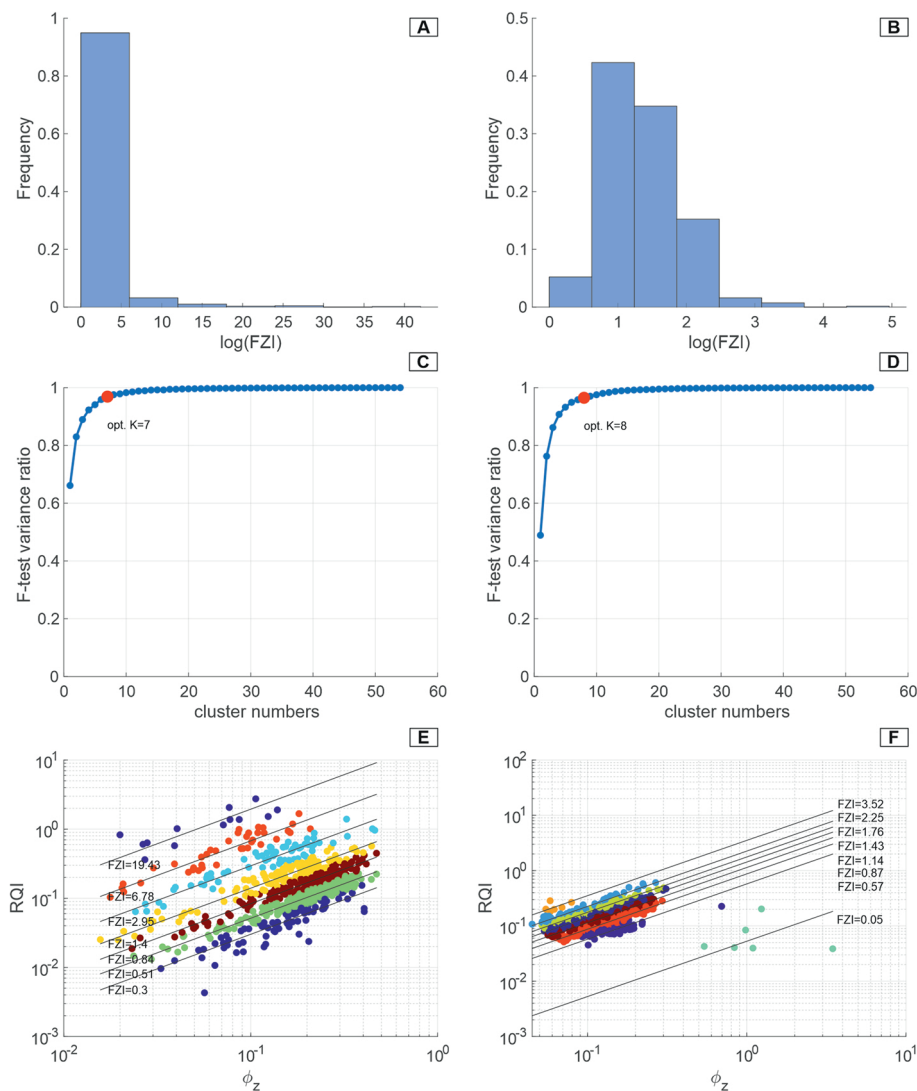


Fig. 10. Results of Amaefule's method of reservoir zonation. Distribution of FZI values in well-A (A) and well-B (B). Optimal number of clusters for Flow Zone Indicator (FZI) values, determined using the Elbow algorithm for well-A (C) and well-B (D). RQI – ϕ_z cross plot for well-A (E) and well-B (F); each line represents a distinct flow zone characterized by its respective intercept, which corresponds to the FZI value. Different colors depict different clusters of FZI values.

across the Zagros region, especially in the Persian Gulf and Fars areas, have documented these burial-related modifications and their substantial impact on reservoir quality (Mehrabi et al., 2015a, 2015b; Mehrabi, 2023).

In conclusion, the Sarvak Formation's diagenetic history comprises three principal phases: marine, meteoric, and burial diagenesis (Fig. 15). While each phase has contributed to the final diagenetic character, meteoric processes - through their creation of dissolution porosity, distinctive cements, and weathering features - have exerted the most significant influence on porosity development. Marine diagenesis played a crucial role in early fabric stabilization, while burial processes substantially modified the carbonates at depth, collectively determining the formation's ultimate reservoir characteristics (Abbasi et al., 2024; Mehrabi et al., 2024).

5.3. Facies-controlled diagenesis

The diagenetic evolution of the Sarvak Formation in the Zagros Basin demonstrates a complex interplay between depositional facies characteristics and subsequent diagenetic alterations,

collectively exerting significant control on reservoir quality. Through comprehensive frequency analysis and detailed petrographic examination, the observed diagenetic features can be systematically classified into three distinct groups based on their genetic relationships with sedimentary facies attributes (Fig. 16).

5.3.1. Diagenetic processes directly related to facies

Several diagenetic features of the Sarvak Formation are strongly linked to its depositional facies, highlighting how different environments promote specific diagenetic pathways. These include dissolution, cementation, and dolomitization processes (Fig. 16).

Dissolution is predominantly observed in high-energy facies, such as MF4 and MF5, where the dissolution of aragonitic components (e.g., mollusk and rudist shells) leads to the formation of vuggy and moldic porosity (Mehrabi, Omidvar et al., 2023). This is consistent with observations in the study by Assadi et al. (2023), where dissolution was linked to marine and meteoric influences in rudist-bearing facies. Additionally, MF7 (rudist & coral rudstone/floatstone) demonstrates significant dissolution and the development of secondary porosity in patch-reef environments, supporting findings by Vitali et al. (2002) regarding patch-reef facies

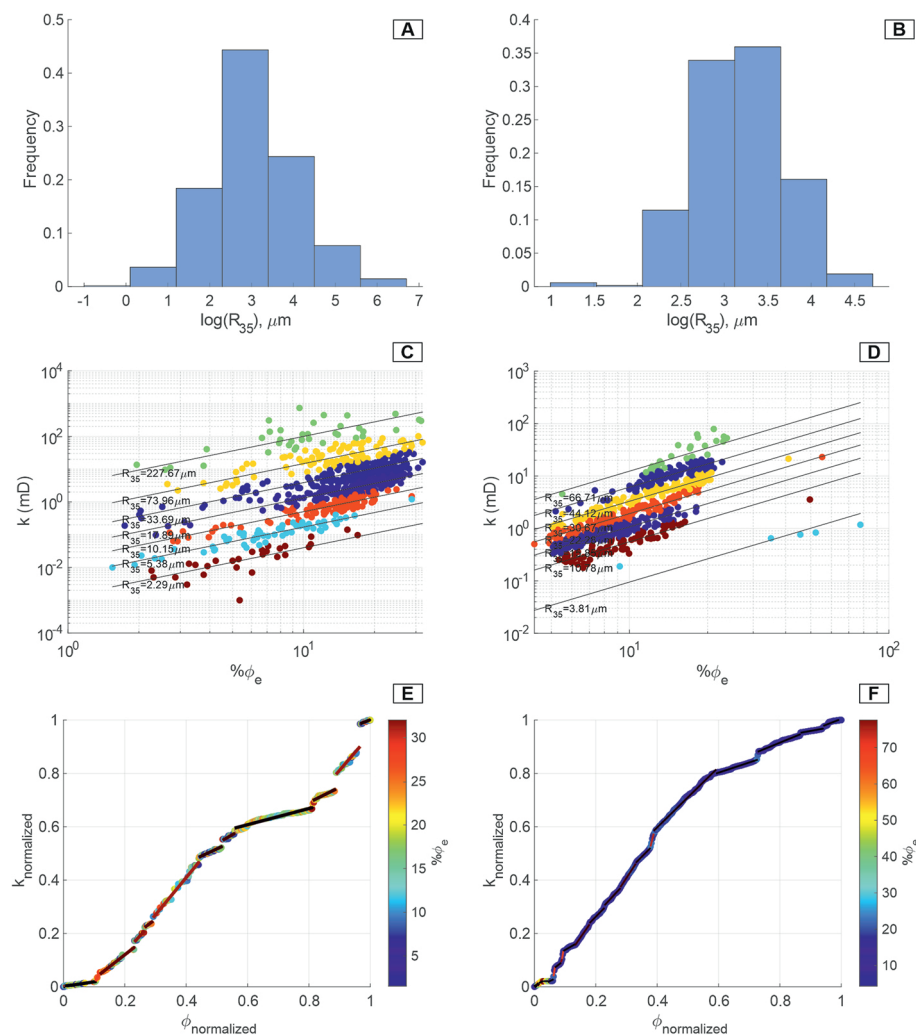


Fig. 11. Results of Gunter's method of reservoir zonation. Distribution of R35 values in well-A (A) and well-B (B). Winland's cross plot for well-A (C) and well-B (D). SMLP; each linear segment indicates points with similar flow potential; well-A (E) and well-B (F).

dissolution in other Cretaceous carbonate systems. Similar dissolution patterns were also noted in the Funing Formation in China by Li et al. (2018), where shoal facies exhibited enhanced porosity due to dissolution processes. The observed dissolution in MF4, MF5, and MF7 aligns with the frequency analysis results (Section 4.4.3), where dissolution was more prevalent in grain-supported and patch-reef facies, contributing to enhanced vuggy porosity.

Cementation follows a clear facies pattern, with grain-supported facies such as MF4 and MF5 exhibiting intense isopachous and drusy cementation, which reduces porosity (Moore and Wade, 2013). The study by Aqrabi et al. (2010) observed similar trends of cementation in grainstone facies of the Mishrif Formation (the stratigraphic equivalent of the Sarvak Formation in Iraq), where early cementation reduced the overall reservoir quality, despite the initial porosity offered by the high-energy depositional environment. The cementation intensity varies based on the facies type, with patch-reef facies (MF-7) showing an increased occurrence of drusy, blocky and syntaxial overgrowth cementation, as identified in Krause et al. (2019). Comparable cementation effects were described by Carvalho et al. (2022) in the Santos Basin, where grainstone facies exhibited varied cementation intensities linked to their structural positions. This trend aligns with the cementation patterns observed in Section 4.4.3,

where MF-4, MF-5, and MF-7 exhibit the highest cementation frequency, impacting porosity retention in these facies.

Dolomitization, primarily in MF-1, MF-2, and MF-8 is strongly controlled by the low-energy environments where fine-grained facies are prevalent. The partial dolomitization of these mud-supported facies results in the formation of intercrystalline porosity, particularly in the presence of Mg-rich fluids during burial diagenesis. This pattern is supported by Rahimpour-Bonab et al. (2012b), who demonstrated the dominance of dolomitization in mud-dominated facies in the adjacent region of the Zagros Basin. Additionally, Taghavi et al. (2006) observed that dolomitization in the Sarvak Formation was influenced by sea-level fluctuations, enhancing reservoir quality when coupled with dissolution processes.

The dominance of dolomitization in mud-supported facies, as indicated in Section 4.4.3 (Fig. 8C), further supports this observation, highlighting its occurrence in MF-1, MF-2, MF-3, and MF-8, particularly around stylolites. According to Mehrabi et al. (2016, 2025), dolomites associated with stylolites predominantly occur in mud-dominated facies of lagoonal and mid-to-outer ramp environments, as these facies are particularly prone to developing pressure dissolution features including dissolution seams and stylolites. The open-marine facies of the Sarvak Formation contain abundant echinoderm fragments, which originally consisted of

Table 2
Summary of Hydraulic Flow Units (HFUs) and their integration with sedimentological data.

Code	FUS	Main Lithology	Major Depositional Setting	Main Stratigraphical Position	Major Diagenesis Features	Porosity Type	Well	K _h (mD)	Phi _h (%)	R ₃₅	RQI	FZI	Efficiency Rank
HFU1	0 < FUS < 0.1	Limestone, (Dolomitic) Limestone	Inner Ramp (Shoal, Lagoon), Mid Ramp	TST and RST	Cementation, Compaction	Moldic, Interparticle, Vuggy	A	Min Max Ave	3.54 13.17 11.81	6.57 14.19 12.15	0.06 0.12 0.11	0.48 2.90 1.35	Low
							B	Min Max Ave	7.38 60.83 9.93	3.33 27.9 18.49	0.04 0.18 0.12	0.04 1.96 1.24	
HFU2	0.1 < FUS < 0.4	(Dolomitic) Limestone	Inner Ramp (Reef, Lagoon), Mid Ramp	RST and TST	Dolomitization, Compaction	Intercrystalline, Microporosity	A	Min Max Ave	9.56 29.09 19.35	10.75 41.10 33.33	0.13 0.33 0.19	0.82 3.16 1.42	Normal
							B	Min Max Ave	15.45 13.09 9.47	21.38 21.23 42.67	0.19 0.14 0.27	1.98 1.50 2.34	
HFU3	0.4 < FUS < 0.7	(Dolomitic) Limestone	Mid Ramp, Inner Ramp (Lagoon)	RST	Fracturing, Dolomitization	Intercrystalline, Microporosity	A	Min Max Ave	4.75 14.69 13.62	24.26 40.09 33.85	0.20 0.33 0.32	2.34 4.65 2.72	High
							B	Min Max Ave	15.05 33.76 34.39	62.22 76.89 67.11	0.39 0.44 0.41	1.55 2.47 1.86	
HFU4	FUS > 0.7	Limestone	Inner Ramp (Reef)	RST	Dissolution, Fracturing	Vuggy, Intraparticle, Interparticle	A	Min Max Ave	21.03 55.67 21.03	78.61 78.61 78.61	0.50 0.50 0.50	2 2 2	Excellent
							B	Min Max Ave	12.94 34.38 38.25	67.99 72.76 70.38	0.41 0.42 0.42	2.54 3 2.77	
									14.67 13.81				

high-Mg calcite (HMC). These biogenic components served as a significant magnesium source during pressure dissolution processes, facilitating subsequent dolomitization. In the Sarvak Formation, stylolite-related dolomites are commonly observed in mud-dominated facies as fine-to-medium crystalline dolomites exhibiting cloudy centers with clear rims, preferentially concentrated along solution seams and stylolite surfaces (Fig. 4J and K).

The dolomitization process produced distinct textures depending on the original lithology: micritic limestones (mudstones and wackestones) transformed into microcrystalline dolomite and early fabric-destructive dolomites, while grain-supported lithologies (packstones and grainstones) developed fabric-destructive dolomites. Importantly, dolomitization along stylolites and dissolution seams significantly enhanced permeability in dolostones and dolomitic limestones by creating interconnected networks that facilitated fluid migration (Afroogh and Mehrabi, 2023; Ibrahim et al., 2023; Morad et al., 2018).

5.3.2. Diagenetic processes indirectly related to facies

Certain diagenetic alterations in the Sarvak Formation show a direct relationship with depositional facies, while others exhibit less facies dependency yet still demonstrate correlations through textural and compositional characteristics (Fig. 16).

Fracturing appears to be most pronounced in dolomitized facies, as seen in MF-1 to MF-3 and MF-8. These facies, with their dolomitized matrix, are more susceptible to fracturing. In contrast, limestone facies show less fracturing, due to their higher ductility and resistance to brittle deformation. Similar findings were reported by Foroshani et al. (2023), who noted that fractured mud-supported facies in the Sarvak Formation provided crucial speed/baffle zones affecting reservoir heterogeneity. This observation aligns with the frequency analysis in Section 4.4.3 (Fig. 9C), which indicates that MF-8 exhibits the highest fracture intensity among the analyzed microfacies.

Comprehensive integration of multi-scale datasets—including core analyses, image logs, production records, and mud loss data—by Ezati et al. (2018) reveals that fractures in the Sarvak reservoir do not consistently enhance reservoir quality. The observed fractures typically exhibit limited vertical and lateral extent, resulting in impacts that are primarily confined to plug-scale measurements. For fractures to significantly improve reservoir performance, they must form an interconnected, permeable network capable of facilitating fluid flow at the reservoir scale. However, current analyses indicate that micro-fractures within the Sarvak Formation generally lack sufficient connectivity and density to substantially influence overall reservoir quality.

Chemical compaction processes are more prominent in mud-supported facies such as MF-1 to MF-3 and MF-8, where stylolites and solution seams dominate. In contrast, grain-supported facies within shoal (MF-4 to MF-6) and patch-reef (MF-7) environments exhibit pervasive evidence of mechanical compaction. These effects manifest through distinct microtextural modifications, including grain deformation and breakage, development of linear to concave-convex grain contacts and significant grain deformation (Fig. 4H).

The higher-pressure dissolution in mud-dominated facies results in a more compacted fabric and reduced porosity. These findings corroborate Assadi et al. (2023) study on the Sarvak Formation, where pressure solution was evident in the fine-grained, mud-supported facies, significantly affecting reservoir quality. Henares et al. (2014) observed similar trends in the Triassic TAGI analogue in SE Spain. The frequency analysis in Section 4.4.3 supports this observation, showing that MF-1, MF-2, MF-3, and MF-8 exhibit the highest compaction-related features (Fig. 9A). previous researches on the Cretaceous carbonate sequences in the Zagros Basin revealed that mud-supported intervals of these

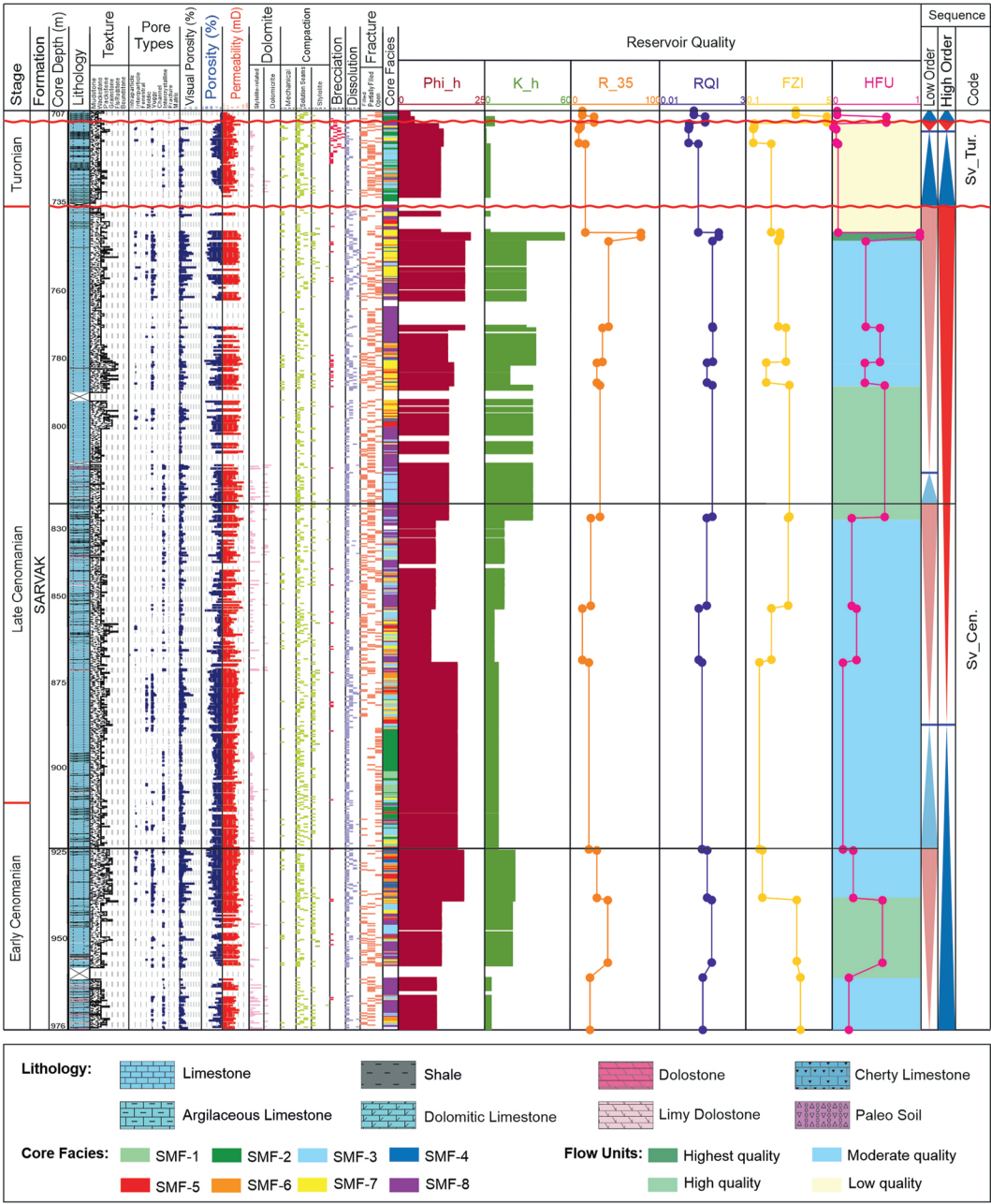


Fig. 12. Integrated sedimentological, petrophysical and reservoir quality evaluation log of the Sarvak Formation in well-A.

sequences were intensively affected by chemical compaction and, subsequently, by stylolites-related dolomitization (e.g., Mehrabi et al., 2025; Rahimpour-Bonab et al., 2012b).

5.3.3. Diagenetic processes unrelated to facies

Some diagenetic alterations appear to be largely independent of facies and are instead driven by regional factors such as temperature, pressure, and the chemical composition of diagenetic fluids (Nader et al., 2024). Pyritization and silicification are observed across various facies, regardless of their depositional environment. These processes seem to occur during burial and meteoric diagenesis and may be linked to the influx of diagenetic fluids rich in sulfur and/or silica. Pyrite mineralization, identified in several samples, is indicative of reducing conditions during deep burial, and silicification is often seen in association with early

cementation and the replacement of carbonate grains, as described by Sadooni (2005). Similar silicification patterns were noted by Mehrabi, Karami et al. (2023) in the Abadan Plain portion of the Sarvak Formation, particularly beneath paleoexposure surfaces. The widespread nature of these processes, observed across all microfacies in Section 4.4.3, supports the assertion that they are unrelated to facies but instead driven by geochemical conditions. Neomorphism (recrystallization) occurs in various facies of the Sarvak Formation. This process can occur in different diagenetic realms such as meteoric and burial environments (Moore and Wade, 2013). Consequently, effects of recrystallization were recorded from shallow to deep marine facies in the Sarvak Formation in various parts of the Zagros Basin (Abbasi et al., 2024; Yahyaei et al., 2025) and its stratigraphic counterparts throughout the Middle East (Mahdi et al., 2013).

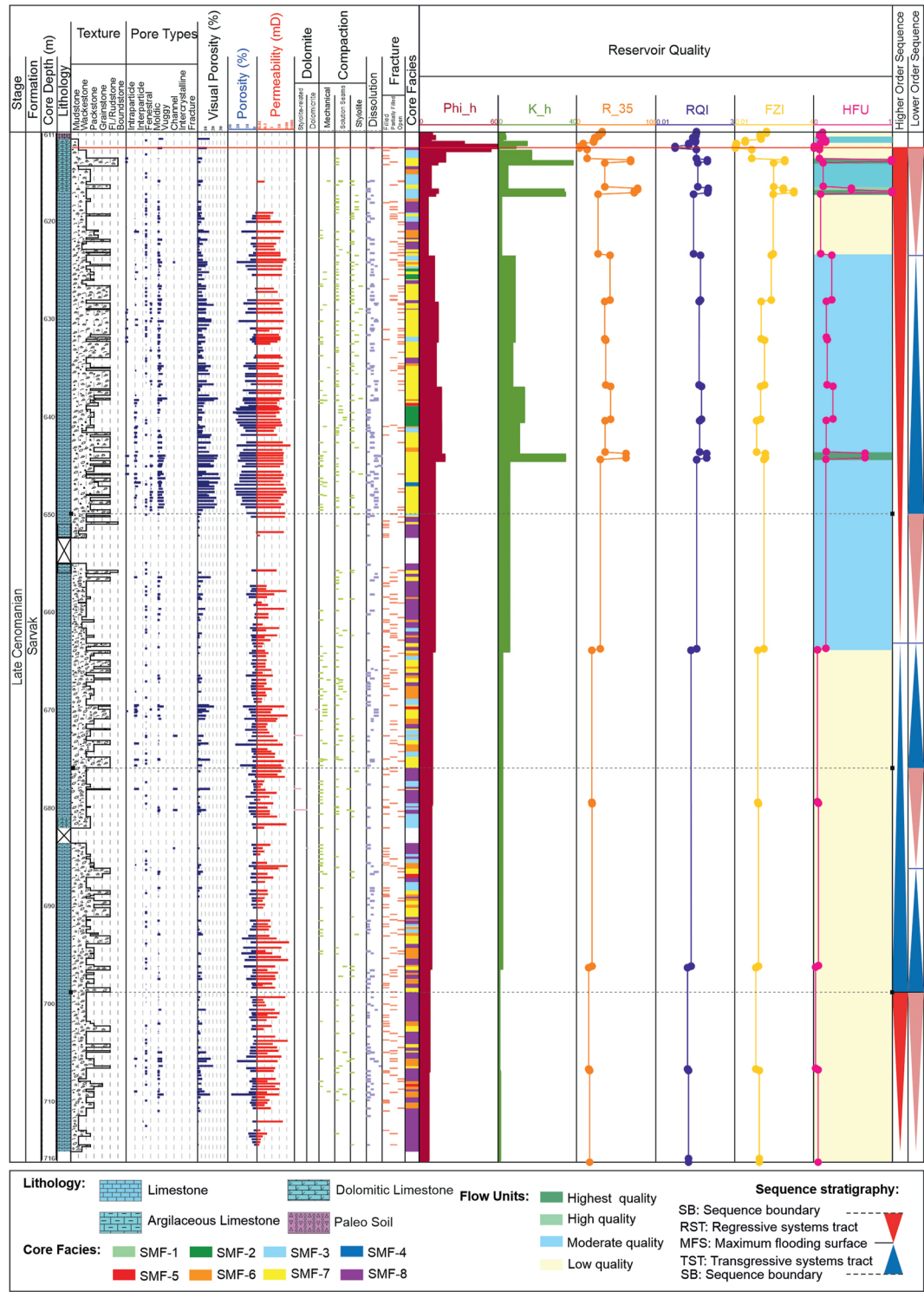


Fig. 13. Integrated sedimentological, petrophysical and reservoir quality evaluation log of the Sarvak Formation in well-B.

5.4. Diagenesis in sequence stratigraphic framework

The diagenetic features of the Sarvak Formation do not occur randomly but are influenced by the relative sea-level fluctuations, which means that they are predictable in a sequence stratigraphic framework (Fig. 16). By analyzing the diagenetic processes categorized in Section 5.3 — ‘directly related to microfacies,’ ‘indirectly

related to microfacies,’ and ‘unrelated to microfacies’ — within the context of sequence stratigraphy, we can interpret their distribution across transgressive systems tracts (TST), regressive systems tracts (RST), maximum flooding surfaces (MFS), and sequence boundaries (SB). This section explores how diagenesis in the Sarvak Formation can be related to the relative sea-level changes and, consequently, to the sequence stratigraphic positions.

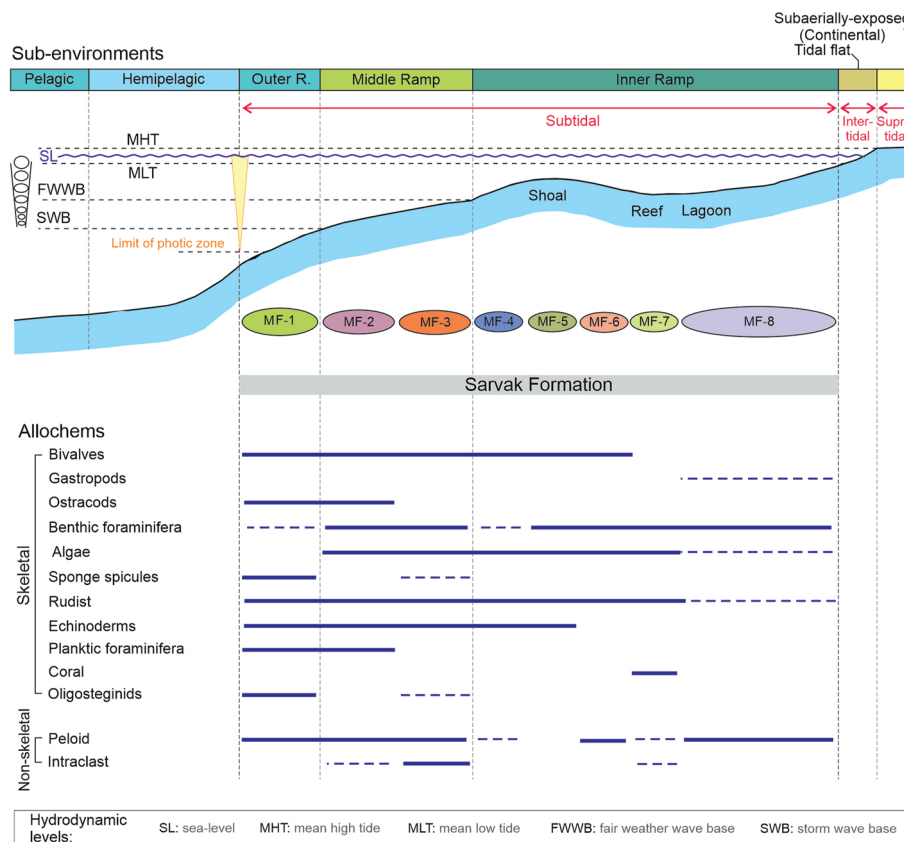


Fig. 14. Conceptual depositional model of the Sarvak Formation in the studied field, Abadan Plain (adopted with some modifications from van Buchem et al., 2011). Lateral distribution of microfacies types is shown along with their allochems.

5.4.1. Transgressive systems tract (TST)

During transgressive phases, rising sea levels created deeper-water environments that favored specific early diagenetic processes. Marine cementation was particularly active in grain-supported facies (MF-4, MF-5), where isopachous fibrous cements developed under prolonged seawater saturation (Saller and Winterbottom, 2023). While these cements reduced primary porosity, they helped stabilize grain frameworks against later compaction (Fallah-Baghtash et al., 2020). In low-energy facies (MF-1, MF-2), extensive micritization occurred through algal and microbial activity, transforming primary textures while creating microporosity networks. Late (burial) dolomitization was observed in mud-dominated facies (MF-1, MF-3) through the action of burial Mg-rich fluids, with dolomite crystals preferentially nucleating along stylolites and dissolution seams (Mehrabi et al., 2025).

5.4.2. Regressive systems tract (RST)

The shallowing conditions during regression resulted in fundamentally different diagenetic processes. High-energy deposits (MF-4 to MF-6 and MF-7) developed in late RST contain substantial secondary porosity (10–25%) through meteoric dissolution of aragonitic components, creating well-connected vuggy and moldic pore systems. Mechanical compaction became increasingly important, evidenced by grain breakage and concave-convex contacts in packstones (MF-5, MF-6), reducing porosity by approximately 15% compared to cemented counterparts (Croizet et al., 2013). Burial-related dolomitization commenced in muddy facies of early RST (MF-1, MF-2), with 50–100 μm dolomite crystals forming preferentially along stylolites and significantly enhancing permeability.

5.4.3. Maximum flooding surface (MFS)

The sediment-starved conditions at maximum flooding left distinct diagenetic signatures. Chemical compaction features like stylolites and solution seams became concentrated in MFS-proximal facies, with insoluble residues reducing porosity by 5–10%. Authigenic mineralization was prominent during these quiescent periods, with pyrite framboids (<10 μm) occluding pores in pelagic facies, particularly where the MFS intersected outer ramp deposits (Minisini et al., 2025).

5.4.4. Sequence boundary (SB)

Sequence boundaries represent the most impactful diagenetic horizons, recording prolonged subaerial exposure. Two regional paleoexposure surfaces were recorded in the Sarvak Formation across the Zagros Basin: (i) the Cenomanian–Turonian boundary exposure surface (known as CT-ES) and (ii) the mid-Turonian exposure surface (known as mT-ES) (Navidtalab et al., 2016; Mehrabi et al., 2022a, 2022b; Simmons et al., 2025). Patch-reef facies (MF-7) near these surfaces typically exhibit 20–30% dissolution porosity with associated brecciation and/or meteoric cementation and recrystallization (Esrafil-Dizaji et al., 2015). In lagoonal settings (MF-8), pedogenic processes created characteristic paleosol features and brecciation reducing porosity to <5%.

The diagenetic processes in the Sarvak Formation show clear links to its sequence stratigraphic framework. Cementation and dissolution directly correlate with microfacies and sequence boundaries, reflecting facies-specific responses to sea-level changes. Dolomitization and fracturing relate more to burial depth and fluid flow, occurring frequently in RSTs and low-energy TSTs. Other features like pyritization, silicification and brecciation

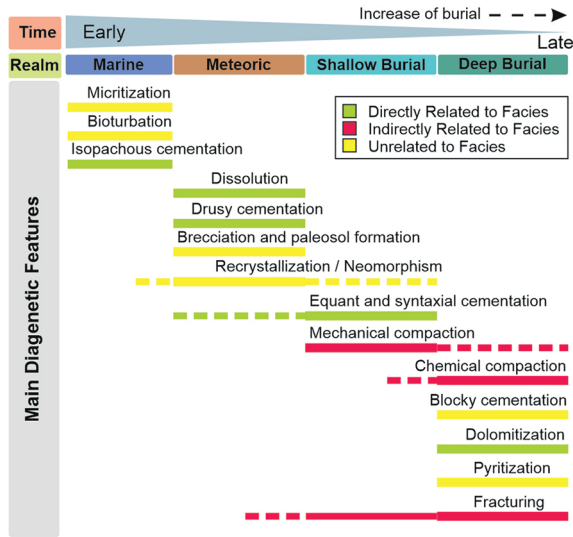


Fig. 15. Paragenetic sequence of the Sarvak Formation in the Zagros Basin (Abadan Plain).

depend mainly on regional geochemical or tectonic factors, often associated with MFS and SB.

5.5. Implications for hydrocarbon exploration and production

The integrated microfacies, diagenetic, and HFU analysis of the Sarvak Formation provides critical insights for optimizing

hydrocarbon exploration and production in the Abadan Plain and analogous carbonate reservoirs. The study demonstrates that the highest-quality reservoir zones (HFU3 and HFU4) are strongly associated with facies-controlled dissolution in rudist-rich (MF-7) and shoal facies (MF-4 to MF-6) beneath sequence boundaries, where meteoric leaching enhances vuggy and moldic porosity, as well as fracture-enhanced dolomitization in mid-ramp dolomitic facies (MF-2, MF-3) with stylolite-related dolomitization that improve permeability. These findings enable predictive targeting of sweet spots where dissolution and fracturing synergistically enhance porosity-permeability networks.

For drilling and completion strategies, horizontal wells should prioritize patch-reef (MF-7) and grain-dominated shoal facies (MF-5, MF-6) near paleoexposure surfaces in high-permeability HFU4 zones, while hydraulic fracturing can effectively stimulate dolomitized HFU2–HFU3 intervals with intercrystalline porosity. Low-quality HFU1 zones are best avoided unless fracture networks are confirmed through image logs or seismic attributes.

Regarding reservoir management, water flooding will be most effective in HFU3–HFU4 zones with connected pore systems, whereas gas injection is preferred for HFU2 units with moderate permeability but high microporosity. Exploration teams should note that stylolite-rich HFU1 intervals may pose geomechanical risks during completions due to stress anisotropy.

Regionally, the established facies–diagenesis–HFU relationships serve as an analogue for underexplored ramp margins where similar TST–RST transitions may host dissolution-enhanced reservoirs, as well as deep-burial plays where dolomitized HFU3 zones could retain porosity at greater depths than limestone-dominated facies. This workflow highlights the value of integrating sequence

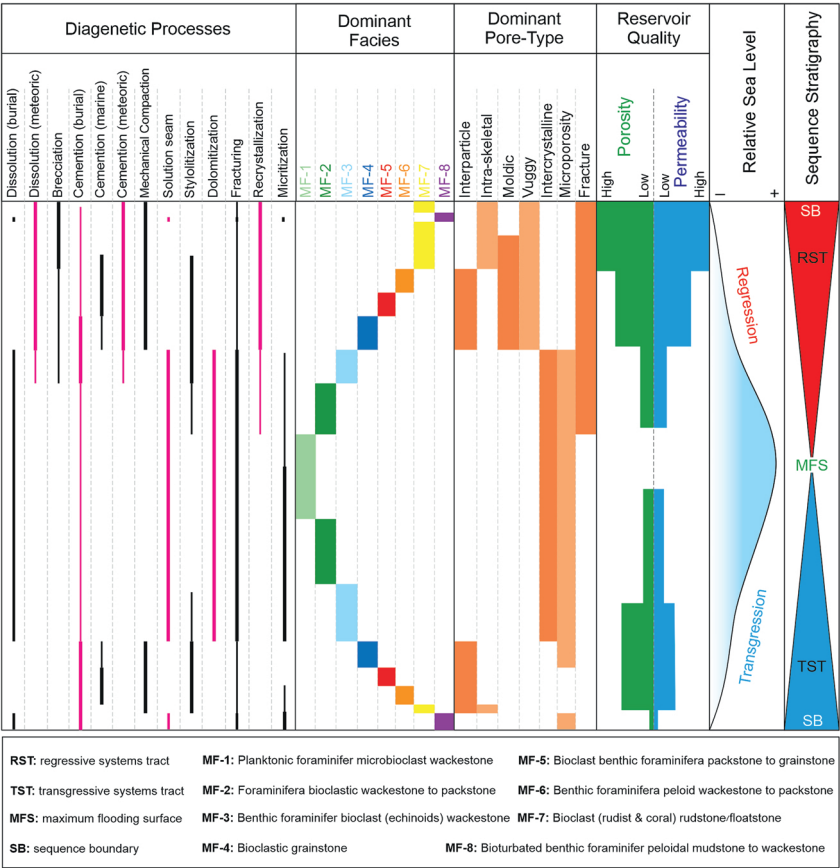


Fig. 16. Integration of diagenetic features of the Sarvak Formation in the studied area with sedimentary facies attributes and sequence stratigraphy.

stratigraphy with diagenetic and petrophysical analysis to reduce uncertainty in carbonate reservoir development, with future exploration efforts recommended to prioritize 3D seismic mapping of sequence boundaries and MFS intervals to identify prospects with optimal diagenetic overprints. The key advantages of this approach include reduced drilling risk through predictable diagenetic facies-HFU relationships, optimized completion designs based on pore system types, and an improved framework for reservoir modeling in heterogeneous carbonates.

6. Conclusions

- The Sarvak Formation exhibits distinct facies-controlled diagenetic patterns, with depositional environments exerting primary control over subsequent alteration processes. Petrographic analysis reveals three dominant diagenetic regimes that show clear facies associations: (1) dissolution features preferentially developed in inner-platform facies, (2) cementation fabrics concentrated in high-energy shoal deposits, and (3) dolomitization processes predominantly affecting outer-ramp facies (Fig. 16). This facies-dependent diagenetic partitioning fundamentally controls the spatial distribution of reservoir quality within the formation.
- The diagenetic history of the Sarvak Formation is intrinsically linked to its sequence stratigraphic architecture, with distinct diagenetic processes associated with each systems tract and key stratigraphic surface. This systematic relationship between depositional environment and subsequent alteration exerts fundamental control on reservoir quality distribution.
- The distribution of reservoir quality reflects this complex stratigraphic-diagenetic interplay. Optimal reservoir characteristics occur in RST grainstones with dissolution-enhanced porosity, SB-adjacent dolomitized zones, and select TST intervals where early cementation preserved porosity. This predictable distribution provides a powerful tool for reservoir quality prediction, explaining the observed 30%+ variability between different stratigraphic positions. The hierarchical controls – from facies-selective processes to burial alterations and tectonic overprints – must be considered for effective exploration and production, particularly in identifying zones where multiple porosity-enhancing processes operated synergistically.
- The reservoir quality distribution across the Sarvak Formation's HFUs is fundamentally governed by the interplay of five key diagenetic processes: cementation, compaction, dolomitization, dissolution, and fracturing. These alterations are strongly facies-dependent, with each microfacies type predisposing sediments to specific diagenetic pathways. The resulting HFUs represent distinct diagenetic end-members – from cement-dominated low-quality zones to dissolution/fracture-enhanced excellent reservoirs – that collectively demonstrate how diagenetic overprints control pore system architecture, storage capacity, and flow efficiency in carbonate reservoirs. This facies-to-diagenesis relationship provides a predictive framework for reservoir quality assessment in analogous carbonate systems.

CRedit authorship contribution statement

Hanieh Mollaali: Writing – original draft, Software, Resources, Methodology, Investigation. **Hamzeh Mehrabi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Conceptualization. **Mohammadfarid Ghasemi:** Writing – original draft,

Visualization, Validation, Supervision, Software, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The University of Tehran and Shahid Beheshti University provided facilities for this research for which the authors are grateful. The National Iranian Oil Company (NIOC) is acknowledged for data support. Journal editors and reviewers are thanked for their valuable comments and suggestions.

References

- Abbasi, R., Mehrabi, H., Yahyaei, E., Rahimpour-Bonab, H., 2024. Diagenetic evolution of Upper Cretaceous carbonate sequences (Sarvak formation) in the Abadan plain, Iran: evidence from petrographic, elemental, stable, and strontium isotopic data. *Int. Geol. Rev.* 66 (22), 3793–3813. <https://doi.org/10.1080/00206814.2024.2361276>.
- Abdollahi, A., Bahrehvar, M., Mehrabi, H., Omidvar, M., Kadhodaie, A., Wood, D.A., 2024. Paleoclimate changes across the Cenomanian–Santonian transition at the southern neo-tethys margin (SW Iran): an integrated approach. *Gondwana Res.* 131, 208–236. <https://doi.org/10.1016/j.gr.2024.02.013>.
- AbdollahieFard, I., Braathen, A., Mokhtari, M., Alavi, S.A., 2006. Interaction of the Zagros Fold–Thrust Belt and the Arabian-type, deep-seated folds in the Abadan Plain and the Dezful Embayment, SW Iran. *Pet. Geosci.* 12 (4), 347–362. <https://doi.org/10.1144/1354-079305-706>.
- AbdollahieFard, I., Sherkat, S., McClay, K., Haq, B.U., 2019. Tectono-sedimentary evolution of the Iranian zagros in a global context and its impact on petroleum habitats. In: Ali, F.S. (Ed.), *Tectonic and Structural Framework of the Zagros Fold–Thrust Belt*, vol. 3. Elsevier, pp. 17–28. <https://doi.org/10.1016/B978-0-12-815048-1.00002-0>.
- Abedi, Y., Mosaddegh, H., Kavoosi, M.A., 2025. Linking diagenesis to sequence stratigraphy: an integrated approach for understanding and predicting the reservoir quality distribution of the Ilam formation (Santonian) in Abadan Plain, southwest of Iran. *Mar. Petrol. Geol.* 177, 107399. <https://doi.org/10.1016/j.marpetgeo.2025.107399>.
- Afroogh, A., Mehrabi, H., 2023. How geomechanical attributes control the morphology of stylolites in carbonate sequences? A case from Permian–Triassic gas reservoirs in the Persian Gulf. *Geomech Energy Environ* 33, 100424. <https://doi.org/10.1016/j.gete.2022.100424>.
- Ahr, W.M., 2008. *Geology of Carbonate Reservoirs*. Wiley. <https://doi.org/10.1002/9780470370650>.
- Alipour, M., 2024. Petroleum systems of the Iranian Zagros fold and thrust belt. *Result Earth Sci* 2, 100027. <https://doi.org/10.1016/j.rines.2024.100027>.
- Al-Jabri, R.A., Al-Maamari, R.S., Wilson, O.B., 2015. Klinkenberg-corrected gas permeability correlation for Shuaiba carbonate formation. *J. Petrol. Sci. Eng.* 131, 172–176.
- Alsharhan, A., 2014. Petroleum systems in the Middle East. *Geological Society* 392 (1), 361–408. London, Special Publications.
- Amaefule, J.O., Altunbay, M., Tiab, D., Kersey, D.G., Keelan, D.K., 1993. Enhanced reservoir description: using core and log data to identify hydraulic (flow) units and predict permeability in uncored intervals/wells. Paper Presented at the SPE Annual Technical Conference and Exhibition?
- Aqrawi, A., Mahdi, T., Sherwani, G., Horbury, A., 2010. Characterization of the mid-cretaceous Mishrif reservoir of the southern Mesopotamian basin, Iraq. Paper Presented at the American Association of Petroleum Geologists Conference and Exhibition.
- Asadi Mehmandosti, E., Adabi, M.H., Woods, A.D., 2013. Microfacies and geochemistry of the middle Cretaceous sarvak formation in Zagros Basin, Izeh Zone, SW Iran. *Sediment. Geol.* 293, 9–20. <https://doi.org/10.1016/j.sedgeo.2013.04.005>.
- Assadi, A., Honarmand, J., Moallelemi, S.A., Abdollahie-Fard, I., 2023. Impacts of depositional facies and diagenesis on reservoir quality: a case study from the rudist-bearing Sarvak Formation, Abadan Plain, SW Iran. *Acta Geologica Sinica - English Edition* 97 (1), 190–206. <https://doi.org/10.1111/1755-6724.14984>.
- Atashbari, V., Tingay, M., Amrouch, K., 2018. Stratigraphy, tectonics and hydrocarbon habitat of the Abadan plain basin: a geological review of a prolific middle Eastern hydrocarbon Province. *Geosciences* 8 (12), 496.
- Bagherpour, B., Mehrabi, H., Faghih, A., Vaziri-Moghaddam, H., Omidvar, M., 2021. Tectono-eustatic controls on depositional setting and spatial facies distribution of Coniacian–Santonian sequences of the Zagros Basin in Fars area, S. Iran. *Mar. Petrol. Geol.* 129, 105072. <https://doi.org/10.1016/j.marpetgeo.2021.105072>.

- Bahrami, P., Sahari Moghaddam, F., James, L.A., 2022. A review of proxy modeling highlighting applications for reservoir engineering. *Energies* 15 (14), 5247. <https://doi.org/10.3390/en15145247>.
- Bassi, D., 2005. Larger foraminiferal and coralline algal facies in an upper Eocene storm-influenced, shallow-water carbonate platform (Colli Berici, north-eastern Italy). *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 226 (1–2), 17–35.
- Bernasconi, S.M., Pika-Biolzi, M., 2000. A stable isotope study of multiple species of planktonic Foraminifera across sapropels of the Tyrrhenian Sea, ODP Site 974. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 158 (3–4), 281–292. [https://doi.org/10.1016/S0031-0182\(00\)00054-7](https://doi.org/10.1016/S0031-0182(00)00054-7).
- Boix, C., Vicens, E., Riera, V., Oms, O., 2023. Rudist reef structure: insights from orientation of hippuritids at l'Espà (Campanian, southern Pyrenees). *Cretac. Res.* 147, 105507. <https://doi.org/10.1016/j.cretres.2023.105507>.
- Burgener, L., Hyland, E., Reich, B.J., Scotese, C., 2023. Cretaceous climates: mapping paleo-köppen climatic zones using a Bayesian statistical analysis of lithologic, paleontologic, and geochemical proxies. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 613, 111373. <https://doi.org/10.1016/j.palaeo.2022.111373>.
- Cao, Z., Lin, C., Dong, C., Ren, L., Han, S., Dai, J., Xu, X., Qin, M., Zhu, P., 2018. Impact of sequence stratigraphy, depositional facies, diagenesis and CO₂ charge on reservoir quality of the lower cretaceous Quantou Formation, Southern Songliao Basin, China. *Mar. Petrol. Geol.* 93, 497–519. <https://doi.org/10.1016/j.marpetgeo.2018.03.015>.
- Carvalho, A.M.A., Hamon, Y., De Souza Jr, O.G., Carramal, N.G., Collard, N., 2022. Facies and diagenesis distribution in an Aptian pre-salt carbonate reservoir of the Santos Basin, offshore Brazil: a comprehensive quantitative approach. *Mar. Petrol. Geol.* 141, 105708.
- Catuneanu, O., Galloway, W.E., Kendall, C.G.S.C., Miall, A.D., Posamentier, H.W., Strasser, A., Tucker, M.E., 2011. Sequence stratigraphy: methodology and nomenclature. *Newsl. Stratigr.* 44, 173–245.
- Cestari, R., Sartorio, D., 1995. Rudists and facies of the periadriatic domain. In: Agip, S.P.A. (Ed.), *Rudists and Facies of the Periadriatic domain/Personal Copy*, A.Pizzi S.
- Croizé, D., Renard, F., Gratier, J.-P., 2013. Compaction and porosity reduction in carbonates: a review of observations, theory, and experiments. *Adv. Geophys.* 54, 181–238. <https://doi.org/10.1016/B978-0-12-380940-7.00003-2>.
- Daraei, M., Bayet-Goll, A., Ansari, M., 2017. An integrated reservoir zonation in sequence stratigraphic framework: a case from the Dezful Embayment, Zagros, Iran. *J. Petrol. Sci. Eng.* 154, 389404. <https://doi.org/10.1016/j.petrol.2017.04.038>.
- Di Stefano, P., Ruberti, D., 2000. Cenomanian rudist-dominated shelf-margin limestones from the Panormide Carbonate Platform (Sicily, Italy): facies analysis and sequence stratigraphy. *Facies* 42, 133–160.
- Du, Y., Zhang, J., Zheng, S., Xin, J., Chen, J., Li, Y.-Z., 2015. The rudist buildup depositional model, reservoir architecture and development strategy of the cretaceous Sarvak formation of Southwest Iran. *Petroleum* 1 (1), 16–26. <https://doi.org/10.1016/j.petlm.2015.04.001>.
- Dunham, R.J., 1962. Classification of carbonate rocks according to depositional textures. *AAPG Memoir* 1.
- Embry, A.F., 2002. Transgressive-regressive (TR) sequence stratigraphy. In: 22nd Annual Gulf Coast Section SEPM Foundation Bob F. Perkins Research Conference.
- Embry, A.F., Klován, J.E., 1971. A late Devonian reef tract on northeastern Banks Island, NWT. *Bull. Can. Petrol. Geol.* 19 (4), 730–781.
- Embry, A.F., Johannessen, E.P., 2017. Two approaches to sequence stratigraphy. *Stratigraph Timescales* 2, 85–118. <https://doi.org/10.1016/bs.sats.2017.08.001>.
- Esfandyari, M., Mohseni, H., Heidari, M., 2023. Facies analysis, depositional sequences and platform evolution of the Sarvak Formation (late Albian-Turonian) in the Zagros Basin, West of Iran. *J. Afr. Earth Sci.* 198, 104811. <https://doi.org/10.1016/j.jafrearsci.2022.104811>.
- Esfarili-Dizaji, B., Rahimpour-Bonab, H., Mehrabi, H., Afshin, S., Kiani Harchegani, B., Shahverdi, N., 2015. Characterization of rudist-dominated units as potential reservoirs in the middle Cretaceous Sarvak Formation, SW Iran. *Facies* 61 (3). <https://doi.org/10.1007/s10347-015-0442-8>.
- Esfarili-Dizaji, B., Rahimpour-Bonab, H., 2019. Carbonate reservoir rocks at giant oil and gas fields in SW Iran and the adjacent offshore: a review of stratigraphic occurrence and poro-perm characteristics. *J. Petrol. Geol.* 42 (4). <https://doi.org/10.1111/jpg.12741>.
- Ezati, M., Azizzadeh, M., Riahi, M.A., Fattahpour, V., Honarmand, J., 2018. Characterization of micro-fractures in carbonate Sarvak reservoir, using petrophysical and geological data, SW Iran. *J. Petrol. Sci. Eng.* 170, 675–695.
- Fallah-Baghtash, R., Jafarian, A., Husinec, A., Adabi, M.H., 2020. Diagenetic stabilization of the Upper Permian Dalan Formation, Persian Gulf Basin. *J. Asian Earth Sci.* 189, 104144. <https://doi.org/10.1016/j.jseae.2019.104144>.
- Fallah-Baghtash, R., Bayet-Goll, A., Omidpour, A., Kakemem, U., 2025. Reservoir quality drivers in the Oligo-Miocene Asmari Formation, Dezful Embayment, Iran: facies, diagenesis, and tectonic controls. *Mar. Petrol. Geol.* 173, 107279. <https://doi.org/10.1016/j.marpetgeo.2024.107279>.
- Flügel, E., 2013. *Microfacies of Carbonate Rocks*. Springer. <https://doi.org/10.1007/978-3-662-08726-8>.
- Foroshani, J.S., Mehrabi, H., Rahimpour-Bonab, H., 2023. Reservoir heterogeneity of Upper Cretaceous Sarvak Formation in the Dezful Embayment, SW Iran: implications of flow unit distribution, electrofacies analysis and geological-based reservoir zonation. *J. Afr. Earth Sci.* 200, 104882. <https://doi.org/10.1016/j.jafrearsci.2023.104882>.
- Ghasemi, M., Kakemem, U., Husinec, A., 2022. Automated approach to reservoir zonation: a case study from the Upper Permian Dalan (Khuff) carbonate ramp, Persian Gulf. *J. Nat. Gas Sci. Eng.* 97, 104332.
- Gholami Zadeh, P., Adabi, M.H., Sadeghi, A., 2019. Microfacies, geochemistry and sequence stratigraphy of the Sarvak Formation (Mid Cretaceous) in the Kuh-e Siah and Kuh-e Mond, Fars area, southern Iran. *J. Afr. Earth Sci.* 160, 103634. <https://doi.org/10.1016/j.jafrearsci.2019.103634>.
- Gunter, G., Finneran, J., Hartmann, D., Miller, J., 1997. Early determination of reservoir flow units using an integrated petrophysical method. Paper Presented at the SPE Annual Technical Conference and Exhibition?
- Hajikazemi, E., Al-Aasm, I., Coniglio, M., 2017. Diagenetic history and reservoir properties of the Cenomanian-Turonian carbonates in southwestern Iran and the Persian Gulf. *Mar. Petrol. Geol.* 88, 845–857.
- Hammer, E., Mørk, M.B.E., Næss, A., 2010. Facies controls on the distribution of diagenesis and compaction in fluvial-deltaic deposits. *Mar. Petrol. Geol.* 27 (8), 1737–1751. <https://doi.org/10.1016/j.marpetgeo.2009.11.002>.
- Hay, W.W., 2008. Evolving ideas about the Cretaceous climate and ocean circulation. *Cretac. Res.* 29 (5–6), 725–753. <https://doi.org/10.1016/j.cretres.2008.05.025>.
- Henares, S., Caracciolo, L., Cultrone, G., Fernández, J., Viseras, C., 2014. The role of diagenesis and depositional facies on pore system evolution in a Triassic outcrop analogue (SE Spain). *Mar. Petrol. Geol.* 51, 136–151.
- Hollis, C., 2011. Diagenetic controls on reservoir properties of carbonate successions within the Albian-Turonian of the arabian plate. *Pet. Geosci.* 17 (3), 223–241.
- Huber, B.T., Norris, R.D., MacLeod, K.G., 2002. Deep-sea paleotemperature record of extreme warmth during the Cretaceous. *Geology* 30 (2), 123–126.
- Ibrahim, Y., Morozov, V.P., el Kadi, M., Alaa, A., 2023. Porosity enhancement potential through dolomitization of carbonate reservoirs, a case of study from the Euphrates Graben fields, East Syria. *Petroleum* 9 (2), 183–198. <https://doi.org/10.1016/j.petlm.2021.05.005>.
- Jafarian, A., Kakemem, U., Husinec, A., Mehrabi, H., Javanbakht, M., Wang, C., Chen, X., Li, Y., 2024. Depositional facies and diagenetic control on reservoir quality of the Aptian Dariyan Formation, NW Persian Gulf. *Mar. Petrol. Geol.* 165, 106895. <https://doi.org/10.1016/j.marpetgeo.2024.106895>.
- Jafarian, A., Kakemem, U., Husinec, A., Mehrabi, H., Pouyafard, Z., Ghasemi, M., Senemari, S., Saboor, A., Wang, C., 2025. Syn- and post-depositional influences on reservoir quality of the Aptian Dariyan Formation, eastern Persian Gulf. *Pet. Geosci.* 31, 1–22.
- Javed, A., Khan, K.F., Quasim, M.A., Asjad, S., 2023. Diagenetic characteristics and their implications on the reservoir potential of Bajocian Sandstone, Jaisalmer Basin, western Rajasthan, India. *Geosyst Geoenviron* 2 (4), 100219. <https://doi.org/10.1016/j.geogeo.2023.100219>.
- Kakemem, U., Ghasemi, M., Adabi, M.H., Husinec, A., Mahmoudi, A., Anderskov, K., 2023. Sedimentology and sequence stratigraphy of automated hydraulic flow units—the Permian Upper Dalan Formation, Persian Gulf. *Mar. Petrol. Geol.* 147, 105965.
- Keller, G., Adatte, T., Berner, Z., Chellai, E., Stueben, D., 2008. Oceanic events and biotic effects of the Cenomanian-Turonian anoxic event, Tarfaya Basin, Morocco. *Cretac. Res.* 29 (5–6), 976–994.
- Khodaei, N., Rezaee, P., Honarmand, J., Abdollahi-Fard, I., 2021. Controls of depositional facies and diagenetic processes on reservoir quality of the Santonian carbonate sequences (Ilam Formation) in the Abadan Plain, Iran. *Carbonates Evaporites* 36 (2), 19. <https://doi.org/10.1007/s13146-021-00676-y>.
- Kiani, A., Saberi, M.H., ZareNezhad, B., Mehmandosti, E.A., 2022. Reservoir zonation in the framework of sequence stratigraphy: a case study from Sarvak Formation, Abadan Plain, SW Iran. *J. Petrol. Sci. Eng.* 208, 109560.
- Killick, R., Fearnhead, P., Eckley, I.A., 2012. Optimal detection of changepoints with a linear computational cost. *J. Am. Stat. Assoc.* 107 (500), 1590–1598.
- Kolodzie, Jr, S., 1980. Analysis of pore throat size and use of the Waxman-Smiths equation to determine OOIP in Spindle Field, Colorado. In: Paper Presented at the SPE Annual Technical Conference and Exhibition?
- Korbar, T., Fuček, L., Husinec, A., Vlahović, I., Oštrić, N., Matičec, D., Jelaska, V., 2001. Cenomanian carbonate facies and rudists along shallow intraplatform basin margin—the island of Cres (Adriatic Sea, Croatia). *Facies* 45 (1), 39–58. <https://doi.org/10.1007/BF02668104>.
- Kordi, M., Turner, B., Salem, A.M.K., 2011. Linking diagenesis to sequence stratigraphy in fluvial and shallow marine sandstones: evidence from the Cambrian-Ordovician lower sandstone unit in southwestern Sinai, Egypt. *Mar. Petrol. Geol.* 28 (8), 1554–1571. <https://doi.org/10.1016/j.marpetgeo.2011.05.003>.
- Krause, S., Liebetrau, V., Nehrke, G., Damm, T., Büsse, S., Leipe, T., Vogts, A., Gorb, S., Eisenhauer, A., 2019. Endolithic algae affect modern coral carbonate morphology and chemistry. *Front. Earth Sci.* 7, 304.
- Li, L., Wei, J., Yin, H., Xie, J., Ding, Y., Shi, S., 2018. Influence of sedimentary facies on reservoir quality and distribution of diagenetic features in the Funing Formation, Wanglongzhuang Oilfield, Subei Basin, Eastern China. *Arabian J. Geosci.* 11, 1–14.
- Lu, P., Zhang, S., Zhang, G., Zühlke, R., 2023. Early marine carbonate cementation in a relic shelf-edge coral reef North of Miami, Florida: pseudo-coupled depositional and diagenetic modeling. *Geoenergy Sci. Eng.* 231, 212345. <https://doi.org/10.1016/j.geoen.2023.212345>.
- Lubeseder, S., Redfern, J., Boutib, L., 2009a. Mixed siliciclastic-carbonate shelf sedimentation—Lower Devonian sequences of the SW anti-atlas, Morocco. *Sediment. Geol.* 215 (1–4), 13–32. <https://doi.org/10.1016/j.sedgeo.2008.12.005>.
- Lubeseder, S., Redfern, J., Boutib, L., 2009b. Mixed siliciclastic-carbonate shelf sedimentation—Lower Devonian sequences of the SW anti-atlas, Morocco. *Sediment. Geol.* 215 (1–4), 13–32.

- Macedo Penna, R., Costa de Oliveira, L., Souza Rodrigues, L., 2024. Seismic quantitative interpretation of diagenetic processes: a study in Brazilian pre-salt carbonate reservoirs. *Mar. Petrol. Geol.* 170, 107134. <https://doi.org/10.1016/j.marpetgeo.2024.107134>.
- Mahdi, T.A., Aqrabi, A.A.M., Horbury, A.D., Sherwani, G.H., 2013. Sedimentological characterization of the mid-Cretaceous Mishrif reservoir in southern Mesopotamian Basin, Iraq. *GeoArabia (Manama)* 18 (1), 139–174. <https://doi.org/10.2113/geoarabia1801139>.
- Malekzadeh, H., Daraei, M., Bayet-Goll, A., 2020. Field-scale reservoir zonation of the Albian–Turonian Sarvak Formation within the regional-scale geologic framework: a case from the Dezful Embayment, SW Iran. *Mar. Petrol. Geol.* 121, 104586. <https://doi.org/10.1016/j.marpetgeo.2020.104586>.
- Marghani, M.M.A., Zairi, M., Radwan, A.E., 2023. Facies analysis, diagenesis, and petrophysical controls on the reservoir quality of the low porosity fluvial sandstone of the Nubian formation, east Sirt Basin, Libya: insights into the role of fractures in fluid migration, fluid flow, and enhancing the permeability of low porous reservoirs. *Mar. Petrol. Geol.* 147, 105986. <https://doi.org/10.1016/j.marpetgeo.2022.105986>.
- Mehdipour, V., Rabbani, A.R., Kadkhodaie, A., 2023. Geological modeling of diagenetic logs of the Sarvak reservoir in Dezful Embayment, southwestern Iran: implications for geostatistical simulation and reservoir quality assessment. *J. Pet. Explor. Prod. Technol.* 13 (10), 2083–2107. <https://doi.org/10.1007/s13202-023-01670-x>.
- Mehrabi, H., 2023. Deposition, diagenesis, and geochemistry of upper cretaceous carbonates (sarvak formation) in the zagros Basin and the Persian Gulf, Iran. *Minerals* 13 (8), 1078.
- Mehrabi, H., Rahimpour-Bonab, H., 2014. Paleoclimate and tectonic controls on the depositional and diagenetic history of the Cenomanian–early Turonian carbonate reservoirs, Dezful Embayment, SW Iran. *Facies* 60 (1), 147–167. <https://doi.org/10.1007/s10347-013-0374-0>.
- Mehrabi, H., Bagherpour, B., 2022. Scale, origin, and predictability of reservoir heterogeneities in shallow-marine carbonate sequences: A case from Cretaceous of Zagros, Iran. *J. Petrol. Sci. Eng.* 214, 110571. <https://doi.org/10.1016/j.petrol.2022.110571>.
- Mehrabi, H., Bagherpour, B., Honarmand, J., 2020. Reservoir quality and micrite textures of microporous intervals in the Upper Cretaceous successions in the Zagros area, SW Iran. *J. Petrol. Sci. Eng.* 192, 107292. <https://doi.org/10.1016/j.petrol.2020.107292>.
- Mehrabi, H., Fakhar-Shahreza, N., Karami, F., Honarmand, J., 2024. Controls of tectonics and paleoclimate on depositional–diagenetic evolution and pore types of Upper Cretaceous successions (Sarvak Formation) in the Abadan plain, Iran. *Mar. Petrol. Geol.* 170, 107118. <https://doi.org/10.1016/j.marpetgeo.2024.107118>.
- Mehrabi, H., Karami, F., Fakhar-Shahreza, N., Honarmand, J., 2023a. Pore-type characterization and reservoir zonation of the Sarvak Formation in the Abadan Plain, Zagros Basin, Iran. *Minerals* 13 (12), 1464.
- Mehrabi, H., Mansouri, M., Rahimpour-Bonab, H., Tavakoli, V., Hassanzadeh, M., 2016. Chemical compaction features as potential barriers in the Permian–Triassic reservoirs of Southern Iran. *J. Petrol. Sci. Eng.* 145, 95–113. <https://doi.org/10.1016/j.petrol.2016.03.020>.
- Mehrabi, H., Navidtalab, A., Enayati, A., Bagherpour, B., 2022a. Age, duration, and geochemical signatures of paleo-exposure events in Cenomanian–Santonian sequences (Sarvak and Ilam formations) in SW Iran: insights from carbon and strontium isotopes chemostratigraphy. *Sediment. Geol.* 434, 106136. <https://doi.org/10.1016/j.sedgeo.2022.106136>.
- Mehrabi, H., Navidtalab, A., Rahimpour-Bonab, H., Heimhofer, U., 2022b. Geochemical expression of sequence stratigraphic surfaces: a case from Upper Cretaceous shallow-water carbonates of southeastern Neo-Tethys margin, SW Iran. *Cretac. Res.* 140, 105329. <https://doi.org/10.1016/j.cretres.2022.105329>.
- Mehrabi, H., Omidvar, M., Hajikazemi, E., Ahmadi, Y., 2023b. Paleoenvironmental reconstruction, bio-and sequence stratigraphy of Upper Cretaceous (Cenomanian–Santonian) strata in the Persian Gulf, Iran. *Stratigraphic Timescales* 8, 363–412.
- Mehrabi, H., Pouyafard, Z., Bahrehvar, M., Al-Aasm, I.S., 2025. Diverse dolomitization models in the Aptian Dariyan (Shu'aiba) Formation in the Persian Gulf, Iran: evidence from petrography, geochemistry and impact on reservoir quality. *Mar. Petrol. Geol.* 172, 107229. <https://doi.org/10.1016/j.marpetgeo.2024.107229>.
- Mehrabi, H., Rahimpour-Bonab, H., Enayati-Bidgoli, A.H., Esrafil-Dizaji, B., 2015a. Impact of contrasting paleoclimate on carbonate reservoir architecture: cases from arid Permo-Triassic and humid Cretaceous platforms in the south and southwestern Iran. *J. Petrol. Sci. Eng.* 126, 262–283. <https://doi.org/10.1016/j.petrol.2014.12.020>.
- Mehrabi, H., Rahimpour-Bonab, H., Hajikazemi, E., Jamalini, A., 2015b. Controls on depositional facies in Upper Cretaceous carbonate reservoirs in the Zagros area and the Persian Gulf, Iran. *Facies* 61, 1–24.
- Mehrabi, H., Yahyaie, E., Navidtalab, A., Rahimpour-Bonab, H., Abbasi, R., Omidvar, M., Asaadi, A., Honarmand, J., 2023c. Depositional and diagenetic controls on reservoir properties along the shallow-marine carbonates of the Sarvak Formation, Zagros Basin: petrographic, petrophysical, and geochemical evidence. *Sediment. Geol.* 454, 106457.
- Minisini, D., Simo, T., Macquaker, J.H.S., Rudnicki, M.D., 2025. Controls on storage capacity in mudstones. Cementation before sediment compaction and preservation of porosity in lithified rock. *Mar. Petrol. Geol.* 177, 107350. <https://doi.org/10.1016/j.marpetgeo.2025.107350>.
- Moieni, M., Rahimpour-Bonab, H., Tavakoli, V., 2023. Evidence for isolated platform development in the Cenomanian on the passive Margin of neotethys, Southwest Iran. *Minerals* 13 (6), 757. <https://doi.org/10.3390/min13060757>.
- Moghadam, H.S., Stern, R.J., 2021. Subduction initiation causes broad upper plate extension: the Late Cretaceous Iran example. *Lithos* 398, 106296.
- Mohseni, H., Javanmard, R.Z., 2020. New data on sequence stratigraphy of the Sarvak Formation in Malekshahi city, (Ilam province) Zagros basin, Iran. *Mar. Petrol. Geol.* 112, 104035.
- Moore, C.H., Wade, W.J., 2013. Carbonate diagenesis. *Dev. Sedimentol.* 67, 67–89. <https://doi.org/10.1016/B978-0-444-53831-4.00005-7>.
- Morad, S., Ketzer, J.M., de Ros, L.F., 2013. Linking diagenesis to sequence stratigraphy: an integrated tool for understanding and predicting Reservoir quality distribution. In: Amorosi, A. (Ed.), *Linking Diagenesis to Sequence Stratigraphy*. Wiley, pp. 1–36. <https://doi.org/10.1002/9781118485347.ch1>.
- Morad, D., Paganoni, M., Al Harthi, A., Morad, S., Ceriani, A., Mansurbeg, H., Al Suwaidi, A., Al-Aasm, I.S., Ehrenberg, S.N., 2018. Origin and Evolution of Microporosity in Packstones and Grainstones in a Lower Cretaceous Carbonate Reservoir. United Arab Emirates, vol. 435. Geological Society, London, Special Publications, pp. 47–66. <https://doi.org/10.1144/SP435.20>.
- Morad, S., Al-Aasm, I.S., Nader, F.H., Ceriani, A., Gasparrini, M., Mansurbeg, H., 2012. Impact of diagenesis on the spatial and temporal distribution of reservoir quality in the Jurassic Arab D and C members, offshore Abu Dhabi oilfield, United Arab Emirates. *GeoArabia (Manama)* 17 (3), 17–56.
- Motiei, H., 1993. Stratigraphy of zagros. *Treatise Geol Iran* 60 (151), 237–245.
- Nabawy, B.S., El Sharawy, M.S., 2018. Reservoir assessment and quality discrimination of Kareem Formation using integrated petrophysical data, Southern Gulf of Suez, Egypt. *Mar. Petrol. Geol.* 93, 230–246.
- Nader, F.H., Matenco, L.C., Haq, B.U., 2024. Conceptualizing fluid-rock interaction diagenetic models with focus on tectonic settings. *Earth Sci. Rev.* 258, 104951. <https://doi.org/10.1016/j.earscirev.2024.104951>.
- Navidtalab, A., Heimhofer, U., Huck, S., Omidvar, M., Rahimpour-Bonab, H., Ahariour, R., Shakeri, R., 2019. Biochemostratigraphy of an upper Albian–Turonian succession from the southeastern Neo-Tethys margin, SW Iran. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 533, 109255.
- Navidtalab, A., Mehrabi, H., Shafaii Moghadam, H., Rahimpour-Bonab, H., 2024. Strontium isotope proxy of sedimentological records reveals uplift and erosion in the Southeastern Neo-Tethys Ocean during the late Cretaceous. *Sci. Rep.* 14 (1), 3499. <https://doi.org/10.1038/s41598-024-54128-3>.
- Navidtalab, A., Rahimpour-Bonab, H., Huck, S., Heimhofer, U., 2016. Elemental geochemistry and strontium-isotope stratigraphy of Cenomanian to Santonian neritic carbonates in the Zagros Basin, Iran. *Sediment. Geol.* 346, 35–48. <https://doi.org/10.1016/j.sedgeo.2016.10.003>.
- Omidvar, M., Mehrabi, H., Sajjadi, F., Bahramzadeh-Sajjadi, H., Rahimpour-Bonab, H., Ashrafzadeh, A., 2014. Revision of the foraminiferal biozonation scheme in Upper Cretaceous carbonates of the Dezful Embayment, Zagros, Iran: integrated palaeontological, sedimentological and geochemical investigation. *Rev. Micropaleontol.* 57 (3), 97–116. <https://doi.org/10.1016/j.revmic.2014.04.002>.
- Rahimpour-Bonab, H., Mehrabi, H., Enayati-Bidgoli, A.H., Omidvar, M., 2012a. Coupled imprints of tropical climate and recurring emergence on reservoir evolution of a mid-Cretaceous carbonate ramp, Zagros Basin, southwest Iran. *Cretac. Res.* 37, 15–34. <https://doi.org/10.1016/j.cretres.2012.02.012>.
- Rahimpour-Bonab, H., Mehrabi, H., Navidtalab, A., 2012b. Flow unit distribution and reservoir modelling in Cretaceous carbonates of the Sarvak Formation, Abteymour Oilfield, Dezful Embayment, SW Iran. *J. Petrol. Geol.* 35 (3), 213–236. <https://doi.org/10.1111/j.1747-5457.2012.00527.x>.
- Sadooni, F.N., 2005. The nature and origin of Upper Cretaceous basin-margin rudist buildups of the Mesopotamian Basin, southern Iraq, with consideration of possible hydrocarbon stratigraphic entrapment. *Cretac. Res.* 26 (2), 213–224. <https://doi.org/10.1016/j.cretres.2004.11.016>.
- Saller, A., Winterbottom, C., 2023. Deep marine diagenesis, offshore Hawaii and Enewetak, with implications for older carbonates. *The Depositional Record* 9 (3), 526–572. <https://doi.org/10.1002/dep2.216>.
- Scotese, C.R., 2021. An atlas of Phanerozoic paleogeographic maps: the seas come in and the seas go out. *Annu. Rev. Earth Planet Sci.* 49 (1), 679–728.
- Sharifi-Yazdi, M., Rahimpour-Bonab, H., Nazemi, M., Tavakoli, V., Gharechelou, S., 2020a. Diagenetic impacts on hydraulic flow unit properties: insight from the Jurassic carbonate Upper Arab Formation in the Persian Gulf. *J. Pet. Explor. Prod. Technol.* 10 (5), 1783–1802. <https://doi.org/10.1007/s13202-020-00884-7>.
- Sharifi-Yazdi, M., Rahimpour-Bonab, H., Nazemi, M., Tavakoli, V., Gharechelou, S., 2020b. Diagenetic impacts on hydraulic flow unit properties: insight from the Jurassic carbonate Upper Arab Formation in the Persian Gulf. *J. Pet. Explor. Prod. Technol.* 10, 1783–1802.
- Sharland, P.R., Casey, D.M., Davies, R.B., Simmons, M.D., Sutcliffe, O.E., 2004. Arabian plate sequence stratigraphy–revisions to SP2. *GeoArabia (Manama)* 9 (1), 199–214.
- Shehata, A.A., Kassem, A.A., Brooks, H.L., Zuchuat, V., Radwan, A.E., 2021. Facies analysis and sequence-stratigraphic control on reservoir architecture: example from mixed carbonate/siliciclastic sediments of Raha Formation, Gulf of Suez, Egypt. *Mar. Petrol. Geol.* 131, 105160. <https://doi.org/10.1016/j.marpetgeo.2021.105160>.
- Sibley, D.F., Gregg, J.M., 1987. Classification of dolomite rock textures. *J. Sediment. Res.* 57 (6), 967–975.

- Simmons, M.D., Bidgood, M.D., Davies, R.B., Droste, H., Levell, B., Razin, P., van Buchem, F.S.P., 2025. Intra-Turonian stratigraphic reorganization on the Arabian Plate. *Geological Society, London, Special Publications* 545 (1). <https://doi.org/10.1144/SP545-2023-207>.
- Simmons, M.D., Sharland, P.R., Casey, D.M., Davies, R.B., Sutcliffe, O.E., 2007. Arabian Plate sequence stratigraphy: potential implications for global chronostratigraphy. *GEOARABIA-MANAMA* 12 (4), 101.
- Steuber, T., Löser, H., 2000. Species richness and abundance patterns of Tethyan Cretaceous rudist bivalves (Mollusca: hippuritacea) in the central-eastern Mediterranean and Middle East, analysed from a palaeontological database. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 162 (1–2), 75–104. [https://doi.org/10.1016/S0031-0182\(00\)00106-1](https://doi.org/10.1016/S0031-0182(00)00106-1).
- Taghavi, A.A., Mørk, A., Emadi, M.A., 2006. Sequence stratigraphically controlled diagenesis governs reservoir quality in the carbonate Dehloran Field, south-west Iran. *Pet. Geosci.* 12 (2), 115–126.
- Tavakoli, V., Barfizadeh, H., 2024. The role of plate movements on reservoir development of the Iranian carbonate formations: a review of the interplay between tectonics, paleoclimate, and diagenesis. *Result Earth Sci* 2, 100037. <https://doi.org/10.1016/j.rines.2024.100037>.
- Tucker, R., Osberg, P., Berry, H., 2001. The geology of a part of Acadia and the nature of the Acadian orogeny across central and eastern Maine. *Am. J. Sci.* 301 (3), 205–260.
- Van Buchem, F., Simmons, M., Droste, H., Davies, R., 2011. Late Aptian to Turonian stratigraphy of the eastern Arabian Plate—depositional sequences and lithostratigraphic nomenclature. *Pet. Geosci.* 17 (3), 211–222.
- Vitali, F., Longstaffe, F.J., McCarthy, P.J., Plint, A.G., Caldwell, W.G.E., 2002. Stable isotopic investigation of clay minerals and pedogenesis in an interfluvial paleosol from the Cenomanian Dunvegan Formation, NE British Columbia, Canada. *Chem. Geol.* 192 (3–4), 269–287.
- Warren, J., 2000. Dolomite: occurrence, evolution and economically important associations. *Earth Sci. Rev.* 52 (1–3), 1–81.
- Yahyaie, E., Mehrabi, H., Abbasi, R., 2025. Isotopic and sedimentologic proxies of palaeoexposure events and Oceanic anoxic event 2 (OAE2) in the Cenomanian–Turonian neritic carbonates (the Sarvak Formation) in the Abadan Plain, Zagros Basin, Iran. *Geol. J.* <https://doi.org/10.1002/gj.5089>.