



# Hydrocarbon Potential and Organic Matter–Inferred Depositional Conditions of the Shiranish Formation in Diana Subdistrict, Northeastern Iraq: Evidence from FTIR Spectroscopy and Palynological Analysis

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Received: 14 January 2025    Received in revised form: 15 April 2025    Accepted: 15 July 2025

Available online: 01 July 2026

## Abstract

The Shiranish Formation, which is known for its dual function as a source and reservoir rock, is a crucial geological unit for hydrocarbon exploration in northern Iraq. In this work, the kerogen types and organic matter properties of the Shiranish Formation in the Diana Sub-district of the Kurdistan Region of Iraq are examined. Using a combination of FTIR Spectroscopy and visual kerogen microscopy, samples were gathered and examined. The results show that all samples include amorphous organic matter (AOM) predominating, with varying contributions from phytoclasts and palynomorphs, according to palynofacies analysis. This suggests a marine anoxic to dysoxic depositional environment. Functional groups linked to both aromatic and aliphatic chains are identified by FTIR spectra, suggesting the existence of heterogeneous organic matter that is prone to both gas and oil. However, the organic matter is consistently classified as Type II/III with early to peak oil window maturity using the Rock-Eval pyrolysis criteria (TOC, HI, and Tmax). In addition, well-preserved marine palynomorphs like *Arecipites microfoveolatus* and Thermal Alteration Index (TAI) values of 2 to 2.5 suggest early thermal maturity and deposition in suboxic to anoxic marine environments. These findings are further supported by kerogen microscopy, which shows a dominant quantity of liptinite and organized AOM. According to the integrated data, the Shiranish Formation, which was formed in the research region under mostly anoxic marine conditions, is a possible source rock with favorable conditions for hydrocarbon formation.

## Keywords:

Cretaceous, Shiranish, kerogen, Infrared spectroscopy, Iraq.

DOI: [10.33899/injes.v26i3.60914](https://doi.org/10.33899/injes.v26i3.60914), ©Authors, 2026 College of Science, University of Mosul.

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## 1. Introduction

The Shiranish Formation is situated in the Imbricate Zone, High Folded Zone, and subsurface portions of the Low Folded Zone (Kirkuk Embayment) of the Arabian Plate Megasequence (AP 9) (Sharland et al., 2004; Jassim and Buday, 2006; Aqrabi et al., 2010; Lawa, 2018; Abdula and Khailani, 2016). The Shiranish Formation is identified in the northern Iraqi High Folded Zone, northeast of Zakho, close to the settlement of Shiranish Islam by Henson (1940), in Bellen et al. (1959). There are two lithological units in the Shiranish Formation: the bottom unit has thin-bedded marly limestone, and the top unit comprises blue pelagic marls with sporadic thin marly limestone beds rich in microfauna (Bellen et

al., 1959; Buday, 1980). The Shiranish Formation is made up of thin-bedded argillaceous limestones, dolomitic limestones throughout the formation, and blue pelagic marls on top of them. Locally, the formation contains some conglomerates (carbonate gravels), which are the consequence of slumping in the Sinjar Area in northwest Iraq (Al-Mutwali and Al-Juboury, 2005).

According to Abdula et al. (2018), the Late Campanian–Maastrichtian Shiranish Formation of Iraq is described as occurring in Shkawtua Village near the Mergasor Area of Northern Iraq; it is composed of mixed siliciclastic and carbonate strata that are explained as an outer shelf open marine depositional environment. The limestones and marls were deposited during a regional transgressive–regressive cycle. The Shiranish

Formation in Jabal Sinjar, northwestern Iraq, is unconformably overlain by the Paleocene–Lower Eocene group, the Sinjar Formation in the northern part of the Jabal, and the Aaliqi Formation along its eastern side.

According to Malak et al. (2021), the Shiranish Formation in Bekhere Anticline, Bade Village, Kurdistan Region, Northern Iraq contains bioclast grains in the micrite matrix and fossils (planktonic, benthic foraminifera, and nannofossils) as important petrographic elements. The sequence stratigraphy of the Shiranish Formation in the Duhok Region, Northern Iraq, was studied by Alsultan et al. (2022). Four facies zones—Deep Sea, Deep Shelf, Toe Slope, and Slope—are where the majority of the Shiranish Formation was deposited. In northwestern Iraq, the thickness of the Shiranish Formation increases close to the basin center and diminishes close to the sedimentary basin boundary (Al-Dulaimi et al., 2023).

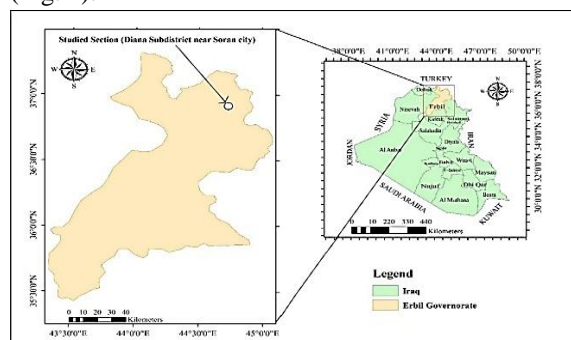
According to Al-Dulaimi et al. (2023), three calcareous nannofossils may have existed in the Shiranish Formation in the Diana Region; the oldest is thought to have been the biozone of *Misceomarginatus pleniporus*, followed by the youngest Biozone 2: *Ceratolithoides aculeus* and Biozone 3: *Uniplanarius sissinghii*.

Hydrocarbons have long been known to be contained in the Upper Cretaceous Shiranish Formation in the Mesopotamian foredeep, especially in the form of Cretaceous oil deposits. But it's also important to recognize its important function as a source rock in NE Syria, and the NE Palmyrides in the nation's center have been identified using geochemical methods (Abboud et al., 2005). In addition to storing hydrocarbons, this geological unit has the capacity to produce them, which adds to the Upper Cretaceous strata's overall oil supply (Abboud et al., 2005). The Shiranish Formation has a dual role in the petroleum system as a source and a reservoir, which increases its significance for hydrocarbon exploration and production in the area (Abboud et al., 2005).

In order to evaluate the hydrocarbon potential, depositional environment, kerogen type, and functional groups of the Shiranish Formation in the Diana Sub-district, Northeastern Iraq, this research will integrate infrared analysis with palynological data.

## 2. Study Area

The research location is located north of Soran City in northeastern Iraq (Diana sector). It is located south of the Hasanbeg Anticline and northwest of the Zozik Anticline. Approximately 36° 40' 88.35" N latitude and 44° 33' 55.40" E longitude are the location's precise coordinates (Fig. 1).



**Fig. 1: Administrative location map displaying the study area in the Diana Sub-district, near Soran City, Erbil Governorate, Kurdistan Region, Iraq.**

## 3. Materials and Methods

The thirteen samples were gathered from the Shiranish Formation outcrop (Fig. 2) in the Kurdistan Region of Iraq's Diana Sub-district in Northern Iraq. The palynological and palynofacies analyses were performed on five samples. Rock-Eval pyrolysis was used to examine three samples. Five samples were subjected to FTIR spectroscopy analysis.

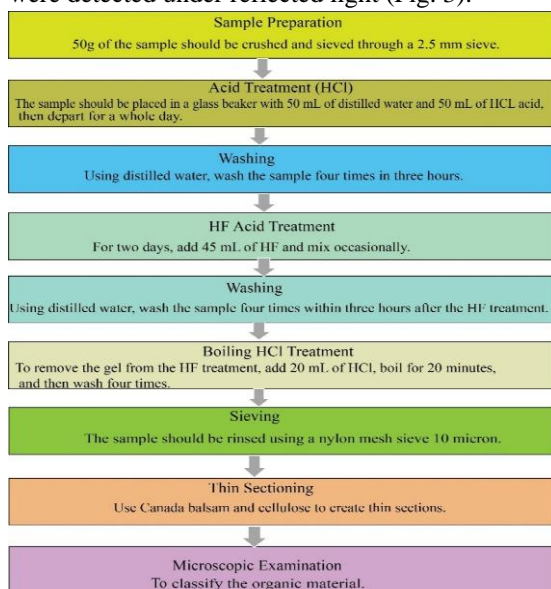


**Fig. 2: Field photograph illustrating the Shiranish Formation in Diana Sub-district (study area), near Soran City, Iraqi Kurdistan.**

Both Soran University and the University of Sulaymani conducted the laboratory work, which involved the following procedures: Sample preparation for palynological examination included grinding the samples and then using physical and chemical processes to remove organic materials from the rock, 30 g of 2 mm sieved

samples were combined with 30 ml of H<sub>2</sub>O and 30 ml of HCl in a glass beaker. The samples were shaken with a rod during the day to speed up the reaction, and this was allowed to react for a full day. Four times, the procedure was carried out. Following the completion of the reaction, the samples underwent four three-hour water washes. In order to break down the silica bonds, the cleaned samples were next combined with 60 milliliters of HF in a plastic beaker. The HF was decanted off once the samples had settled, and they underwent four further water washes. The samples were then heated to eliminate any debris that had developed during the HF treatment after being treated four times with 30 milliliters of HCl. The samples were left overnight after the acid was eliminated and pure water was supplied. After that, distilled water was used to wash them many times until their pH was neutral. Ten µm nylon mesh was used to filter the residues.

After mounting these residues on a coverslip using cellulose, they were affixed to a slide using a small quantity of mounting media (Canada Balsam). Using a microscope, the prepared slides were inspected under transmitted light, and the AOM kerogen with a few palynomorphs and phytoclasts were detected under reflected light (Fig. 3).



**Fig. 3: A general flowchart that shows the stages involved in processing palynofacies (based on Batten and Morrison, 1983)**

Additionally, five rock samples from the formation were analyzed using FTIR Spectroscopy. The FTIR Spectroscopy method can measure the ratio of various bond types, including aliphatic and aromatic bonds, and helps identify

the kerogen type. FTIR Spectroscopy at the University of Sulaymani, Department of Chemistry, was used to evaluate the concentrated kerogens from the chosen samples. The kerogen and potassium bromide (KBr) were combined to create the samples, which were then compressed into pellets at a pressure of 20 kPa. A Perkin-Elmer FTIR spectrometer equipped with KBr pellets was used to record the FTIR. At wave numbers 1630 cm<sup>-1</sup>, 1710 cm<sup>-1</sup>, 2860 cm<sup>-1</sup>, and 2930 cm<sup>-1</sup>, the strength of the main peaks was measured. As well as at the Kurdistan Institution for Strategic Studies and Scientific Research in Sulaymani, samples have been crushed fine to guarantee homogeneity after being oven-dried at 60°C to eliminate moisture. In order to do pyrolysis, samples were heated to 300°C for three minutes, then ramped up to 600°C at a rate of 25°C per minute. Rock-Eval pyrolysis was used for three samples to directly determine the total organic carbon (TOC) levels, HI, and Tmax.

#### 4. Geologic Overview

Iraq may be divided into three main zones based on its tectonic makeup: The Zagros Fold and Thrust Suture Zone, the High Folded Zone, and the Low Folded Zone (Aqrawi et al., 2010; Sissakian and Al-Jiburi, 2014) (Fig. 4). The High Folded Zone encompasses this research region. In this area, a deep marine environment is where the Shiranish Formation was deposited (Buday, 1980; Al-Dulaimi et al., 2023).

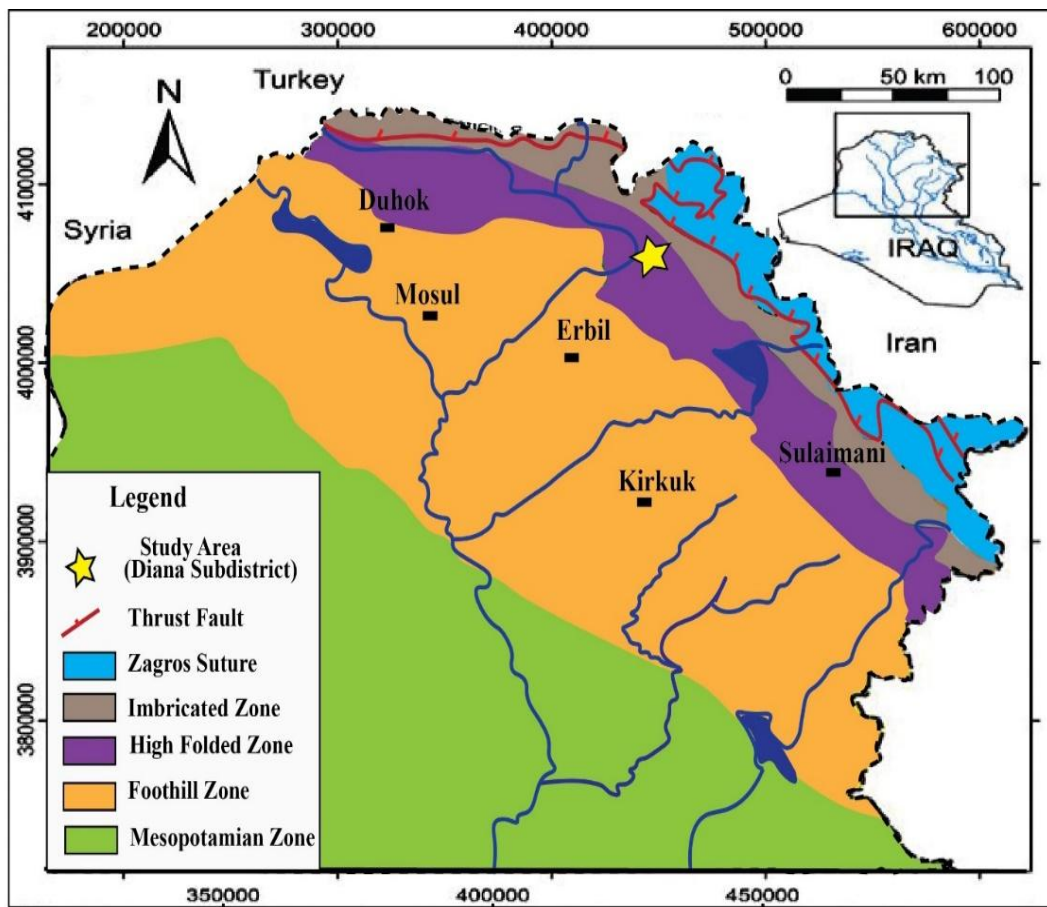


Fig. 4: Tectonic Zones of Northern Iraq and showing the Study Area (Diana Sub-district) (redrawn after Jassim and Buday, 2006).

Atrushi (2007) states that the age of the Shiranish Formation is early-late Maastrichtian, with a depositional environment that ranges from the outer shelf to the upper bathyal, with a concentration in the Duhok Governorate in northern Iraq. He discovered two microfacies and sub-microfacies in the formation in the Khabaz Oilfield in Kirkuk. He also noted deposition in the upper bathyal habitats and outer shelf. Additionally, Hassan (2021) discovered that the Shiranish Formation's sedimentary environment in the Sarah Anticline, Dokan, extends from the outer shelf to the middle bathyal through the research of planktonic foraminifera (Bellen et al., 1959). The thickness of the formation varies between 100 and

400 meters in various regions, but it is around 225 meters in the type section. The thickness of the formation in the present segment is approximately 150 meters.

This fluctuation confirms what Sissakian (2005) found, which was that there were notable thickness variations in Cretaceous rocks throughout Iraq during the Cretaceous Period. In the northern Iraq subdistrict of Diana that has been researched, while the top contact is conformable and gradational with the Tanjero Formation, the bottom contact is abrupt and nonconformable with the Bekhme Formation (Fig. 5), also discovered by Al-Dulaimi et al. (2023).



interpretation of the Shiranish Formation as a possible source rock with a moderate generating capability is supported by these findings, which are

in line with the categorization criteria of Peters and Cassa (1994).

**Table 1: Data on total organic carbon and Rock-Eval pyrolysis parameters of Shiranish Formation samples in the Diana Sub-district.**

Sample No.	Quantity (mg)	TOC (wt.%)	S1 (mg/g)	S2 (mg/g)	Tmax (°C)	S3 (mg/g)	PC (%)	RC (%)	HI (mg/g)	OI (mg/g)
10	71.1	1.52	0.06	2.85	440	0.59	0.27	1.25	188	39
11	71.3	1.54	0.04	2.81	439	0.57	0.29	1.23	192	37
12	69.9	1.53	0.08	2.89	441	0.58	0.28	1.26	186	41

**B. Visual Kerogen**

Twelve prepared slides from five Shiranish Formation samples were seen under a transmitted light microscope. Amorphous organic matter (AOM) has been discovered, as well as a few palynomorphs and phytoclasts. Because of processes, particularly erosion, all of the phytoclasts and palynomorphs discovered present in this environment of the mentioned formation were brought from other places, such as terrestrial environments. Microbial biomass, fine-grained organic detritus, including modified phytoplankton, and degraded marine plankton are the main sources of AOM, which have no distinct structure and disintegrate rapidly in oxygenated environments (Pacton et al., 2011). Palynofacies is an effective analytical tool when used with geophysical and geological data. Information on the depositional environment and potential for producing hydrocarbons may be gleaned from the identification of kerogen types, quantity, and ratios of continental vs marine-derived components (Tyson, 2012). Using organic matter-isolation techniques for sample preparation (kerogen concentration), microscopy techniques as the primary tool for data acquisition, and statistical methods for data interpretation, palynofacies is the study of particulate organic matter found in sediments and sedimentary rocks (Mendonça Filho et al., 2010).

Four categories of amorphous biological materials are distinguished by texture (Thompson and Dembicki, 1986): “Type A is characterized by dense, finely dispersed organic matter with a spotted or clumped appearance; Type B consists of smooth-edged, ellipsoidal particles; Type C is fragmental or granular in texture; and Type D comprises flaky, platy, or lamellar organic particles.” While gas-prone organic matter has

Type A and varies in amounts of Types B, C, and/or D, oil-prone organic matter often contains Types A and/or D separately or in combination. Thompson and Dembicki’s (1986) classification was employed to identify the type of kerogen for the examined specimens. Numerous writers have effectively applied this categorization in Kurdistan (e.g., Mohialdeen, 2008; Ranyayi, 2009; Mohialdeen et al., 2013). The majority of the organic matter under study is Type A, B, and D based on Thompson and Dembicki (1986), suggesting the combination of organic inputs that are prone to gas and oil. AOM, palynomorphs, foraminiferal linings, and structured phytoclasts are all visible in visual kerogen examination. A Thermal Alteration Index (TAI) of 2 to 2.5 indicates that the palynomorphs, which include marine forms and *Arecipites microfoveolatus*, are well-preserved and yellow to orange in color. This indicates a mixed Type II/III kerogen deposited under suboxic to anoxic marine settings and shows early thermal maturity, consistent with Rock-Eval pyrolysis Tmax values of about 440°C.

The model provided by Thompson and Dembicki (1986) states that geochemical elements such as Tmax and Hydrogen Index (HI) must be used to establish the association between different types of amorphous organic matter (AOM) and hydrocarbon potential. Nevertheless, Rock-Eval pyrolysis data were utilized to validate this interpretation in accordance with Thompson and Dembicki (1986). These results indicate a [Type II/III] kerogen with [oil-prone/gas-prone/mixed] potential. The assessment of the sample's source rock potential is strengthened by the combination of palynofacies and geochemical data. (Figs. 6, 7, and 8).

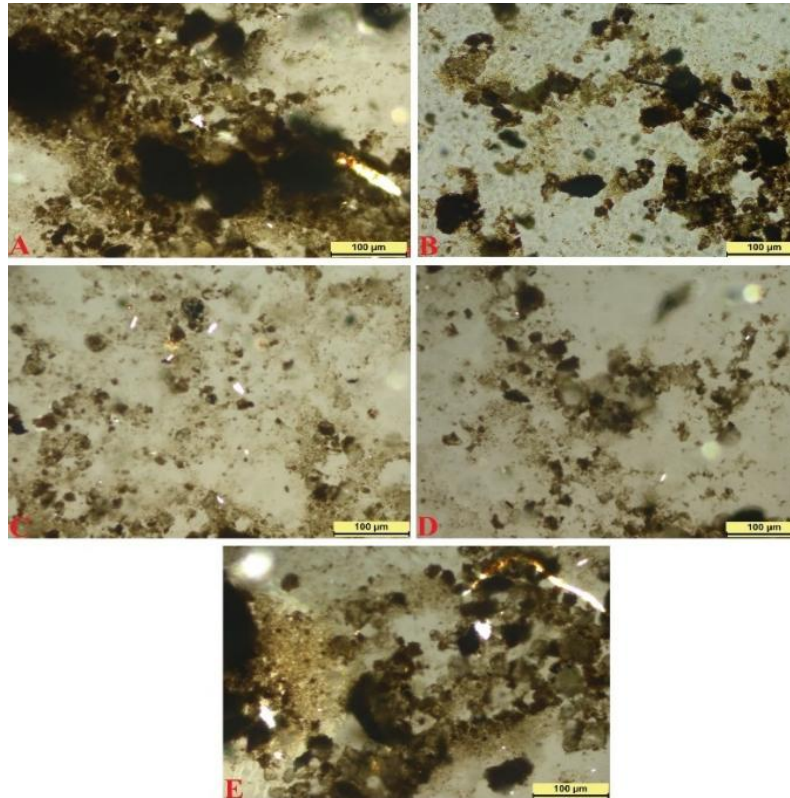


Fig. 6: Organic matter photomicrographs from the Shiranish Formation in Diana Sub-district, Northern Iraq using transmitted white light photographs of typical kerogen assemblages made from five samples displayed on multiple slides. Samples 1, 3, 6, 10, and 19 are shown in (a), (b), (c), and (e), respectively. The predominant component of all slides is amorphous organic matter (AOM). Magnification:  $\times 100$ .

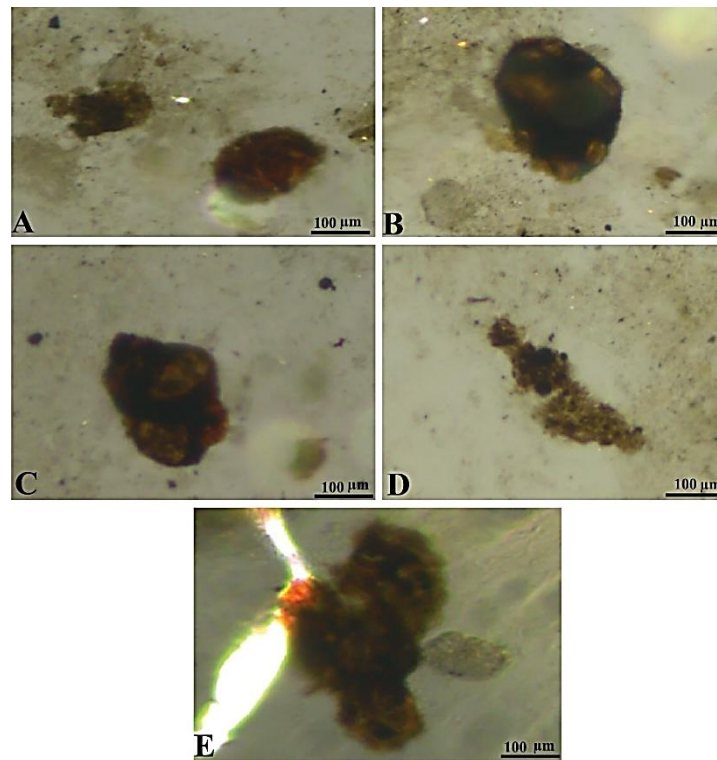
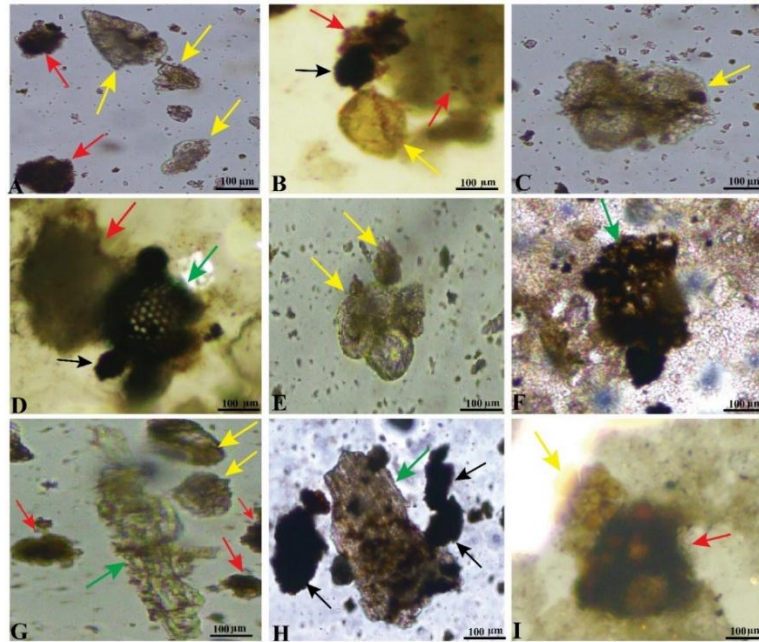


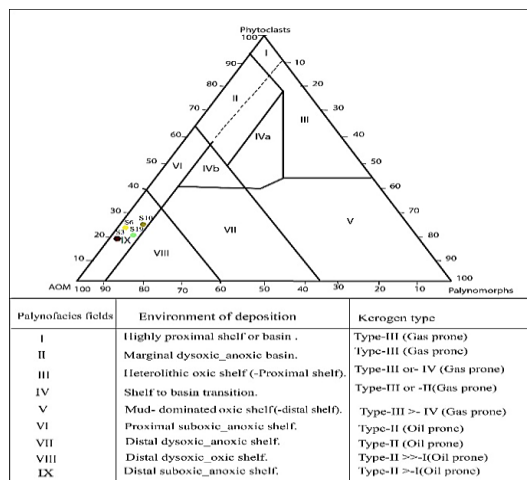
Fig. 7: Photomicrographs of palynofacies (transmitted light) from five typical samples demonstrate that Amorphous Organic Matter (AOM) predominates in the Upper Cretaceous Shiranish Formation in Diana Sub-district, Northern Iraq. Isolated AOM appears as dark brown organic particles without any structure, which suggests that it was deposited in reducing, low-oxygen environments. The following examples are represented in the images: Samples 1 (A), 3 (B), 6 (C), 10 (D), and 19 (E) are shown. Magnification:  $\times 100$ .

With the Tyson ternary diagram (Tyson, 2012), all of the examined samples are situated extremely near the left lower corner of AOM for the categorization of organic materials inside sedimentary rocks due to a high ratio of AOM in all of the samples with few palynomorphs and phytoclasts in the studied samples (Fig. 9).

Sediments deposited in suboxic to anoxic marine environments define this field (IX). This section is therefore regarded as a biological substance that is extremely prone to oil and gas.



**Fig. 8:** Under transmitted light, photomicrographs of the palynofacies from samples 1, 3, 6, 10, and 19 show significant organic components from the Shiranish Formation in Diana Sub district, Northern Iraq. Green arrows and Black arrow represent non opaque and opaque phytoclasts, respectively: Cuticle fragment (g) and wood particle (h), biostructured phytoclast (f), opaque rounded tracheid phytoclast (d), opaque phytoclast in black arrows (b, d, and h). Red arrows: Indicate amorphous organic matter (AOM). Yellow arrows: Suggest transparent palynomorphs: sporomorph *Arecipites microfoveolatus* (b), marine palynomorphs (a, e, and c), also including organic linings of foraminifera (i). Palynomorph color (yellow arrows) corresponds to a TAI of 2–2.5, which is consistent with Rock-Eval Tmax values of around 440°C and suggests early thermal maturity. Scale =100 µm; magnification×100.



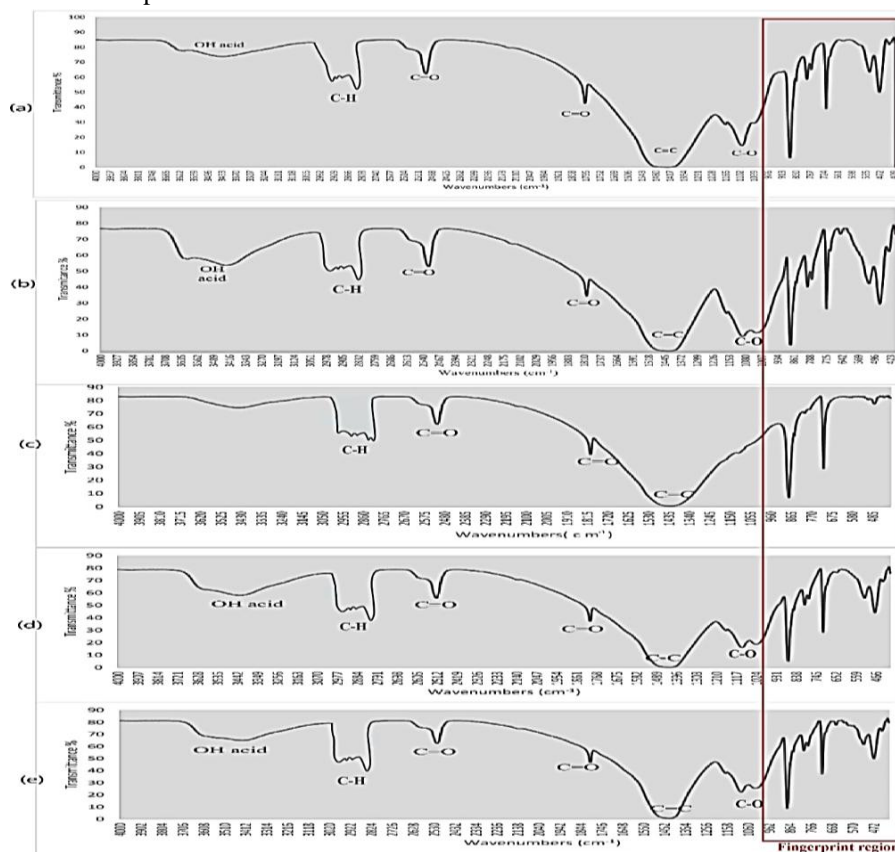
**Fig. 9:** Ternary diagram of phytoclasts, palynomorphs, and amorphous organic matter (AOM). Due to the significant abundance of AOM, as well as a small quantity of phytoclasts and palynomorphs, all of the examined samples are situated in the lower left corner of the figure, nearly on the AOM corner. According to the figure, which was taken from Tyson (2012), the Upper Cretaceous sediments were formed in a marine, suboxic-anoxic marine depositional environment.

## 6. Infrared Spectrometry

One of the earliest analytical methods used on kerogen was infrared spectroscopy (Rouxhet, 1980). Vibrational frequencies are measured by this method and can be linked to certain chemical group, typically, spectra are captured during transmission (Painter et al., 1981), diffuse reflection (Fuller et al., 1982), complete attenuated reflection (Washburn and Birdwell, 2013)

Five samples of rocks from the Shiranish Formation were chosen for infrared spectroscopy. FTIR was used to examine the organic materials of the Shiranish Formation for wave numbers between 400 and 4000  $\text{cm}^{-1}$  (Figs. 10a–d). By using this approach, one may determine the kerogen type and maturity based on the relative strength of the absorption bands linked to

polyaromatic nuclei (benzene), which are the inactive portion of organic matter, and aliphatic  $\text{CH}_2$ ,  $\text{CH}_3$  assemblages, which are the active component of organic matter. When combined with other information, the data from this method can provide a numerical measurement of aliphatic and aromatic bonds in the following range: C–H bonds range from 3100 to 2900  $\text{cm}^{-1}$ , while C=O groups range from 1800 to 1650  $\text{cm}^{-1}$ , and O–H and N–H groups: 3600–3200  $\text{cm}^{-1}$  (Farmer, 1974; Myriam et al., 1998; Gionis et al., 2006). The examination of the examined samples identifies different kerogen types according to their spectral properties when the spectrographs are compared with those from Thompson and Dembicki(1986).



**Fig. 10: Infrared spectra (transmittance) for samples (a)(S4), b(S6), c(S13), d(S15), and e(S18)). The horizontal axis displays the absorption values, the Y-axis is labeled "Percent Transmittance" (T%), and the X-axis of an FTIR spectrum shows the intensity of distinct peaks (1/cm) marked as "Wave number" and ranging between 472 to 4000.**

Nevertheless, a number of the target peaks that Ganz and Kalkreuth (1987) employed in their technique were either weak or poorly developed in the currently available spectra. Low organic matter concentration, problems with sample preparation (such as excessively thick KBr pellets), or instrument sensitivity might be the cause of this.

Adjacent well-developed peaks of the same functional group were utilized for interpretation when the predicted peaks were not visible or overlapped. FTIR was nevertheless used to determine generic functional group compositions in spite of these drawbacks. To guarantee a more precise categorization of the kerogen type and

depositional circumstances, the FTIR data were interpreted in conjunction with palynological observations and accessible geochemical indications. Both aliphatic and aromatic functional groups are indicated by the major absorption bands at 3400–3200 cm<sup>-1</sup> (O–H), 2950–2850 cm<sup>-1</sup> (C–H), 1740 cm<sup>-1</sup> (C=O), 1600 cm<sup>-1</sup> (C=C), and 1030–1150 cm<sup>-1</sup> (C–O) in the FTIR spectra (Figs. 10a–d) (Table 2). The aliphatic and aromatic fractions present in the examined samples are computed using Ganz and Kalkreuth's (1987) (Table 3) equations and plotted on the A and C factors diagram (Fig. 11). Due to the lack of more current revisions (e.g., Mroczkowska-Szerszeń, 2015), the exact peak intensities for A and C factors were computed using Ganz and Kalkreuth's (1987) technique .

The formation's samples are early mature and belong to the type II/III kerogen. A mixed Type II/III kerogen with a significant terrestrial input is

suggested by the presence of oxygenated and aromatic chemicals. As samples mature thermally, aliphatic C–H gradually decreases while aromatic and carbonyl peaks gradually progress. A comprehensive understanding of the origin of organic materials and the hydrocarbon potential in the Shiranish Formation may be obtained by combining TOC, FTIR, and palynofacies investigations. Moderate organic content is confirmed by TOC measurements. Both aliphatic and aromatic functional groups are seen in FTIR spectra, suggesting Type II/III kerogen with a combination of terrestrial and marine input. Palynofacies analysis places samples in the marine domain of the ternary diagram due to their high AOM content and low palynomorph and phytoclast ratios. This provides support to a depositional environment that is dominated by marine environments and possesses a terrestrial component. All of these results point to early thermal maturity and support moderate source rock potential..

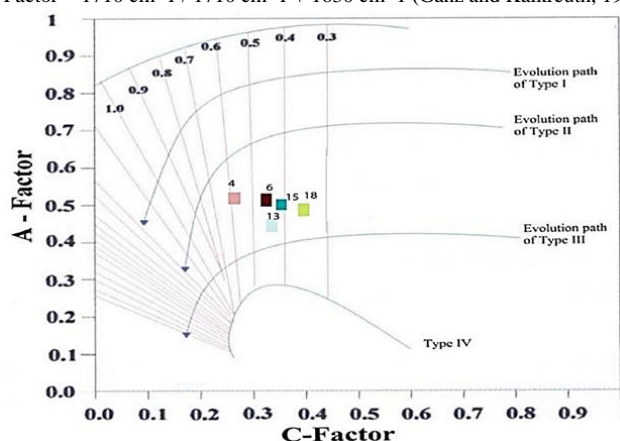
**Table 2: The functional groups assignments and their spectroscopic vibrational assignment.**

Wavenumber (cm <sup>-1</sup> )	Functional Group	Vibrational Mode	Assignment
3400–3200	–OH (Carboxylic acid)	O–H stretching	Broad peak, hydrogen bonding
2920–2850	–CH (Alkanes)	C–H asymmetric and symmetric stretch	Aliphatic C–H bonds
1740–1720	C=O (Carbonyl)	C=O stretching	Esters or acids
1650–1600	C=C (Alkenes or Aromatics)	C=C stretching	aromatic systems
1250–1000	C–O (Esters, Ethers)	C–O stretching	Oxygenated groups
<1000	Miscellaneous	Bending, skeletal vibrations	Fingerprint region

**Table 3: Number of samples, transmittance range of infrared spectra, and A and C factors.**

Sample No.	2930 cm <sup>-1</sup>	2860 cm <sup>-1</sup>	1710 cm <sup>-1</sup>	1630 cm <sup>-1</sup>	A-factor	C-factor
4	37.2	30.3	23.4	60.1	0.52	0.28
6	35.0	34.2	37.1	66.3	0.51	0.35
13	36.3	23.4	40.5	77.1	0.43	0.34
15	33.3	34.0	39.7	69.0	0.49	0.36
18	29.9	30.8	49.8	59.4	0.50	0.45

A-Factor =  $2860 \text{ cm}^{-1} + 2930 \text{ cm}^{-1} / 2860 \text{ cm}^{-1} + 2930 \text{ cm}^{-1} + 1630 \text{ cm}^{-1}$   
 C-Factor =  $1710 \text{ cm}^{-1} / 1710 \text{ cm}^{-1} + 1630 \text{ cm}^{-1}$  (Ganz and Kalkreuth, 1987)



**Fig. 11: A-Factor vs. C-Factor plot of the FTIR data. The five samples are all categorized as Type II/III kerogen (Ganz and Kalkreuth, 1987).**

## 7. Conclusions

The integrated application of palynofacies analysis, Rock-Eval pyrolysis, and Fourier Transform Infrared (FTIR) spectroscopy provides a robust characterization of the organic matter properties in the Shiranish Formation of the Diana Subdistrict, Northern Iraq.

Both aliphatic and aromatic functional groups are present in the FTIR spectra, suggesting a mixed Type II/III kerogen capable of generating both gas and oil. The samples appear to have attained early to peak oil window maturity according to Rock-Eval indices such as total organic carbon, hydrogen index and Tmax, which also demonstrate moderate to excellent organic richness. The presence of early mature, mixed Type II/III kerogen is supported by a thermal alteration index (TAI) of 2.0–2.5 based on the color of well-preserved terrestrial palynomorphs in agreement with Rock-Eval pyrolysis results (e.g., Tmax ~440°C). In accordance with the observed kerogen types and thermal maturity, palynofacies data further suggest a marine-influenced depositional environment with occasional terrestrial input.

## 8. References

Abboud, M., Philp, R. and Allen, J. 2005. Geochemical correlation of oils and source rocks from central and NE Syria. *Journal of Petroleum Geology*, 28, pp. 203-216.

Abdula, R.A. and Khailani, R., 2016. Shiranish Formation in Garota (Shaqlawa, northern Iraq) as raw material for Portland cement manufacturing, *Iraqi Bulletin of Geology and Mining*, 12(1), pp. 65-72.

Abdula, R.A., Balaky, S., Khailani, R., Miran, A., Muhamad, M., and Muhamad, C. 2018. Sedimentology of the Shiranish Formation in the Mergasure area, Iraqi Kurdistan. *Bulletin of the Geological Society of Malaysia*, 65, pp. 37-43. DOI: [10.7186/bgsm65201804](https://doi.org/10.7186/bgsm65201804)

Al-Banna, N.Y. 2010. Sequence stratigraphy of the Late Campanian – Early Maastrichtian Shiranish Formation, Jabal Sinjar, northwestern Iraq. *GeoArabia*, 15(1), pp. 31-44.

Al-Dulaimi, A.M., Al-Haj, M.A., Al-Badrani, O.A. and Al-Juboury, A.I., 2023. Lithostratigraphy and Biostratigraphy of the Shiranish Formation (Late Campanian-Maastrichtian) in Diana area, Northern Iraq. *Iraqi Journal of Science*, pp. 1268-1284. <https://doi.org/10.24996/ijs.2023.64.3.22>

Al-Mutwali, M.M. and Al-Juboury, F.N., 2005. Litho and biostratigraphy of Shiranish Formation (Late Campanian-Maastrichtian) in Sinjar area. *Northwestern Iraq. Rafidian Journal of Science*, 16(1), Geology special issue, pp. 152-176.

Alsultan, H.A.A., Hussein, M.L., Al-Owaidi, M.R.A., Al-Khafaji, A.J. and Menshed, M.A., 2022. Sequence stratigraphy and sedimentary environment of the Shiranish Formation, Duhok region, Northern Iraq. *Iraqi Journal of Science*, 63(11), pp. 4861-4871. <https://doi.org/10.24996/ijs.2022.63.11.23>

Aqrabi, A.A., Goff, J.C., Horbury, A.D. and Sadooni, F.N. 2010. *The petroleum geology of Iraq*, Scientific Press, Beaconsfield, 435 P.

Atrushi, R., 2007. *Sedimentary Shiranish Formation in the Dohuk Region*. Unpublished MSc. Thesis, University of Mosul, College of Science, 131 P.

Bellen, R.C. van, Dunnington, H.V., Wetzel, R., and Morton, D., 1959. *Lexique Stratigraphic International*. Asie, Fasc. 10a, Iraq, Paris.

Bissada, K., Elrod, L., Robison, C., Darnell, L., Szymczym, H. and Trostle, J. 1993. Geochemical inversion- a modern approach to inferring source-rock identity from characteristics of accumulated oil and gas. *Energy exploration and exploitation*, 11, pp. 295-328.

Buday, T., 1980. *The Regional Geology of Iraq*. Vol.1, Stratigraphy and Paleogeography. In: I.I., Kassab and S.Z., Jassim (Eds.). *GEOSURV*, Baghdad, 445 P.

Farmer, V.C., 1974. *The infrared spectra of minerals*. Mineralogical Society Monograph, 4, pp. 331-363.

Fuller, M.P., Hamadeh, I.M., Griffiths, P.R. and Lowenhaupt, D.E., 1982. Diffuse reflectance infrared spectrometry of powdered coals. *Fuel*, 61, pp. 529-536.

Ganz, H. and Kalkreuth, W., 1987. Application of infrared spectroscopy to the classification of kerogen types and the evaluation of source rock and oil shale potentials. *Fuel*, 66, pp. 708-711.

Gionis, V., Kacandes, G.H., Kastritis, I.D. and Chryssikos, G.D., 2006. On the structure of palygorskite by mid-and near-infrared spectroscopy. *American Mineralogist*, 91, pp. 1125-1133.

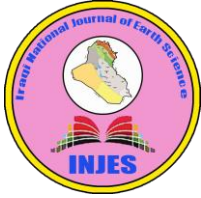
Hassan, Y., 2021. *Biostratigraphy of foraminiferal and depositional environment of Shiranish Formation in Sara anticline in Dokan area/Sulaymani, Northeastern Iraq*. Unpublished MSc. Thesis. University of Mosul, Iraq, 118 P.

Jassim, S.Z. and Buday, T., 2006. Units of the Unstable Shelf and the Zagros Suture, chapter 6, in: Jassim S.Z. and Goff J.C., (eds.), *Geology of Iraq*, first edition: Brno, Czech Republic, Prague and Moravian Museum, pp. 71-83.

Lawa, F.A.A., 2018. Late Campanian–Maastrichtian sequence stratigraphy from Kurdistan foreland basin, NE/Iraq. *Journal of Petroleum Exploration and Production Technology*, 8, pp. 713-732.


Malak, Z.A., Al-Badrani, O.A., and Al-Fandi, E.I., 2021. Stratigraphic and microfacies study of Upper Campanian - Lower Maastrichtian succession (Shiranish Formation) in Bade village, Bekhere anticline, Kurdistan region, northern Iraq. *Bulletin of the Geological Society of Malaysia*, 71, pp. 47-55.

- Mendonça Filho, J., Chagas, R., Menezes, T., Mendonça, J., DA Silva, F., and Sabadini-Santos, E., 2010. Organic facies of the Oligocene lacustrine system in the Cenozoic Taubaté basin, Southern Brazil. *International Journal of Coal Geology*, 84, pp. 166-178.
- Mohialdeen, I., 2008. Source rock appraisal and oil/source correlation for the Chia Gara Formation, Kurdistan, N Iraq. PhD thesis, Unpublished, University of Sulaimani.
- Mohialdeen, I.M., Hakimi, M.H., and Al-Beyati, F.M., 2013. Geochemical and petrographic characterization of Late Jurassic–Early Cretaceous Chia Gara Formation in Northern Iraq: palaeoenvironment and oil-generation potential. *Marine and Petroleum Geology*, 43, pp. 166-177. DOI:[10.1016/j.marpetgeo.2013.02.010](https://doi.org/10.1016/j.marpetgeo.2013.02.010)
- Myriam, M., Suarez, M., and Martin-Posaz, J., 1998. Structural and textural modifications of palygorskite and sepiolite under acid treatment. *Clays and Clay Minerals*, 46, pp. 225-231.
- Pacton, M., Gorin, G.E., and Vasconcelos, C., 2011. Amorphous organic matter — experimental data on formation and the role of microbes. *Review of Palaeobotany and Palynology*, 166, pp. 253-267.
- Painter, P.C., Snyder, R.W., Starsinic, M., Coleman, M.M., Kuehn, D.W., and Davis, A., 1981. Concerning the application of FT-IR to the study of coal: a critical assessment of band assignments and the application of spectral analysis programs. *Applied Spectroscopy*, 35, pp. 475-485.
- Peters, K.E. and Cassa, M.R., 1994. Applied source rock geochemistry: Chapter 5: Part II. Essential elements.
- Ranyayi, K., 2009. Source rock evaluation of Lower Tertiary formations in northeast Iraq. Master's thesis (unpublished), Science College, University of Sulaymani, Iraq, 171 P.
- Rouxhet, P., 1980. Characterization of kerogens and their evolution by infrared spectroscopy. *Kerogen*, pp. 163-190.
- Sharland, P.R., Casey, D.M., Davies, R.B., Simmons, M.D., and Sutcliffe, O.E., 2004. Arabian Plate Sequence Stratigraphy – revisions to SP2. *GeoArabia*, 9(1), pp. 199-214.
- Sissakian, V.K. and Al-Jiburi, B., 2014. Stratigraphy of the high folded zone. *Iraqi Bulletin of Geology and Mining*, 6, pp. 73-16.
- Sissakian, V.K., 2005. The stratigraphy of the exposed Cretaceous rocks in Iraq, as deduced from the results of the regional and detailed geological surveys (GEOSURV 1971-1996). *Iraqi Bulletin of Geology and Mining*, 1, pp. 1-20.
- Thompson, C.L. and Dembicki, H., 1986. Optical characteristics of amorphous kerogens and the hydrocarbon-generating potential of source rocks. *International Journal of Coal Geology*, 6, pp. 229-249.
- Tyson, R.V., 2012. Sedimentary organic matter: organic facies and palynofacies, Springer Science and Business Media.
- Washburn, K.E. and Birdwell, J.E., 2013. Multivariate analysis of ATR-FTIR spectra for assessment of oil shale organic geochemical properties. *Organic Geochemistry*, 63, pp. 1-7. DOI:[10.1016/j.orggeochem.2013.07.007](https://doi.org/10.1016/j.orggeochem.2013.07.007)



## الإمكانات الهيدروكربونية والمواد العضوية- الظروف الترسيبية المستنتجة لتكوين شيرانيش

### في ناحية ديانا، شمال شرق العراق: أدلة من التحليل الطيفي والتحليل الباليينولوجي

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تاريخ الاستلام: 14 كانون الثاني 2025 تاريخ المراجعة: 15 نيسان 2025 تاريخ القبول: 15 تموز 2025  
تاريخ النشر الإلكتروني: 01 تموز 2026

#### المخلص

يُعد تكوين شيرانيش وحدة جيولوجية بالغة الأهمية في استكشاف الهيدروكربونات شمال العراق، نظرًا لوظيفته المزدوجة كمكمن وصخور مصدرية. يتناول هذا البحث تحليل أنواع الكبريتين وخصائص المادة العضوية في عينات مأخوذة من ناحية ديانا ضمن إقليم كردستان العراق، بالاعتماد على تقنيات التحليل الطيفي بالأشعة تحت الحمراء والمجهر البصري. أظهرت نتائج التحليل بالاعتماد على تحاليل السحنات العضوية المجهرية أن جميع العينات تحتوي على مادة عضوية غير متبلورة، مع نسب متفاوتة من بقايا المتحجرات العضوية الدقيقة، مما يشير إلى بيئة ترسيب بحرية تتراوح بين ظروف انعدام الأكسجين (*anoxic*) وظروف نقص الأكسجين (*dysoxic*). أظهرت أطيف الأشعة تحت الحمراء وجود مجموعات وظيفية مرتبطة بكل من المركبات العطرية والأليفاتية، ما يعكس تنوعًا في تركيب المادة العضوية وقدرتها على توليد كل من الغاز والنفط. تُصنف المادة العضوية ضمن الكبريتين من النوع الثاني/الثالث، مع درجة نضج حراري تتراوح من المراحل المبكرة إلى ذروة توليد النفط، استنادًا إلى مؤشرات تحليل الصخور مثل محتوى الكربون العضوي الكلي (*TOC*)، ومؤشر الهيدروجين (*HI*)، ومعامل الحرارة القصوى (*Tmax*)، كما تشير الأشكال البحرية المحفوظة جيدًا، مثل *Arecipites microfoveolatus*، وقيم مؤشر التغير الحراري (*TAI*) بين 2 و2.5، إلى ترسيب في بيئة بحرية قليلة إلى ناقصة الأوكسجين، مع نضج حراري مبكر. تدعم هذه النتائج أيضًا نتائج فحص الكبريتين المجهرية، التي أظهرت وفرة في مكونات الفحم وجزئيات عضوية منتظمة. وبناءً على هذه البيانات المتكاملة، يمكن اعتبار تكوين شيرانيش في منطقة الدراسة صخرًا مصدرًا يمتلك خصائص جيولوجية وبيئية واعدة لتوليد الهيدروكربونات.

#### الكلمات المفتاحية:

الكريتايسي، شيرانيش، كبريتين، التحليل الطيفي، العراق.

DOI: [10.33899/injes.v26i3.60914](https://doi.org/10.33899/injes.v26i3.60914), ©Authors, 2026, College of Science, University of Mosul.

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