



Stratigraphic study of Qalqula Formation, Sulaymaniyah Governorate - NE Iraq

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Abstract

Qulqula Formation studied in Suren mountain - Sulaymaniyah- NE Iraq. 10 samples collected from the outcrop near Kani Seif Hamid area. Petrographic and mineralogical investigation carried out, thin sections, X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray Analysis (EDX) samples were prepared and analysed in Wollongong University-Australia. Preliminary results show that the lower part of Qulqula Formation in the studied section undergo severe recrystallization and partly dolomitized. In addition, from chronostratigraphic viewpoint, Qulqula Formation in the studied area thought to represent Late Triassic age. This study report for the first time the occurrence of Calpionellids fossils, two species were identified; *Tintinnopsella remanei* Borza and *Calpionellites major* (Colom) which represent the Late Jurassic - Early Cretaceous age (i.e. Late Tithonian - Early Valanginian respectively). This coincided with the proposed age results from previous works.

Introduction

Qulqula Formation represents a stratigraphic unit from the Qulqula Group, which divided into two formations; Qulqula radiolarian and Qulqula conglomerate Formations. Qulqula Formation as it described in its type locality consist from alternative of chert, shale and siliceous limestone rocks. The formation age is controversial [1]; [2] and it is assigned by other authors to be early Cretaceous [1]; [3], late Early Cretaceous; Aptian–Albian [4]; [5] or Albian – Cenomanian [6], while [7] proposed the Late Triassic - Late Cretaceous age. This paper aims to study Qulqula Formation from stratigraphic viewpoint, petrography and mineralogy were provided for record.

Study area

The studied section is at Kani Seif Hamid town 12 Km south from Penjween city (Figure 1) located within the Zagros suture zone (i.e. Qulqula-Khwakurk zone) according to the Iraqi tectonic subdivisions [3]. The section is composed from the recrystallized, partly dolomitized, limestone of Qulqula Formation with chert nodules. The Qulqula Formation is thrust on the underlying Late Triassic Avroman Formation. The samples collected near the plunge of the anticline.

Field description

The section is close to the north-west plunger area of the Suren Mountain. It is located about 3km to north-east of Kani Seif Hamid town and about 2km to the west of the Iraqi-Iranian borders. The thickness of the lower Qulqula Formation in the studied section is about 16 m (Figure 2), and the bedding is very clear with frequent inclusions of chert nodules which intercalate the chert beds occasionally (Figure 3C). The carbonate rocks of Qulqula Formation change into marly limestone near the contact between Qulqula and Avroman Formations. In addition to that, chert nodules inclusions decrease in size, and wavy bedding or ripple like bedding present with highly fractured rocks away from the contact towards the lower part of Qulqula Formation. The size of the nodules increases in the lower part of Qulqula Formation to approximately 70-75 cm in some cases. Additionally, dolomitization and recrystallization influenced the formation rocks. On the other hand, Qulqula Formation rocks are darker from surrounding due to the existence of chert nodules and occasionally hydrocarbon spots. Extrusive igneous rocks (1.5 meter in size) recorded near the contact between Qulqula and Avroman Formations.

Furthermore, the beds thickness in most parts ranged from 12- 20 cm as average, and they are identical and semi coherent, thus the separation between the beds are very clear. In general, fracturing increased towards the upper part of the formation due to the

tectonic activity and the presence of the volcanic intrusions (Figure 3A & B), and they are filled with secondary calcite and gypsum. Dip angle of the beds ranged from (50°-33°), the strike is 280 and the dip direction is 10°.

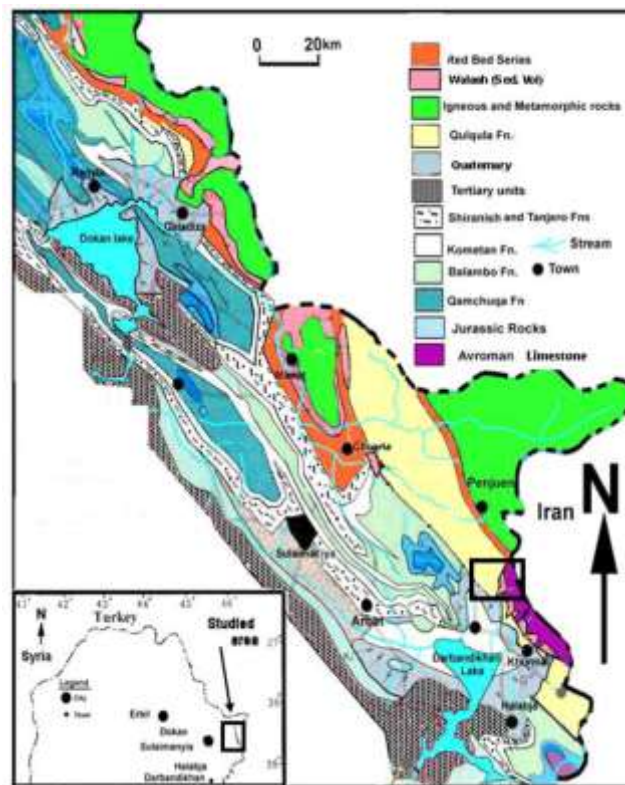


Figure 1. Geological map of the studied area (after [8]; [9]).

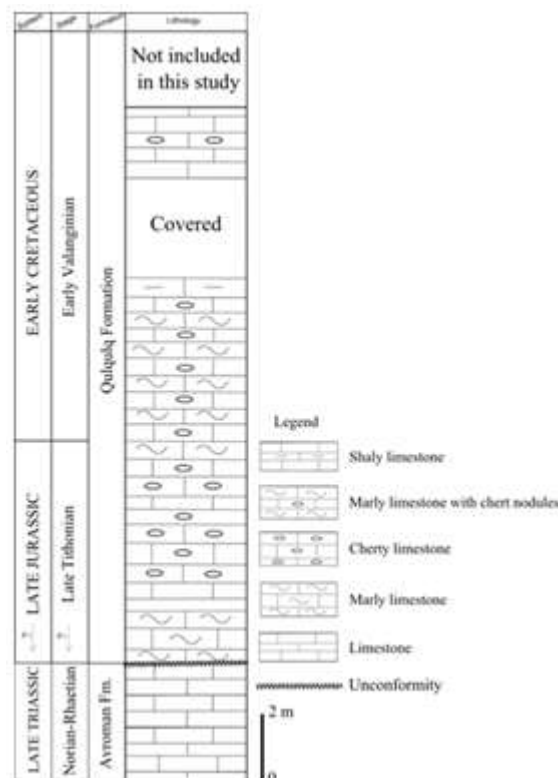


Figure 2. Lithological column of the lower part of Qulqula Formation in the studied section of Kani Seif Hamid town, Suren Mountain. Vertical scale bar is two meters.



Figure 3. A & B represent the presence of the volcanic intrusions within Qulqula Formation in the studied section, C. the chert nodules occurrences.

Methodology

Ten samples collected to represent the lower Qulqula Formation in the studied section. The samples were pulverised and prepared for XRD analysis, fresh broken surfaces coated with gold for SEM-EDX analysis, in Wollongong University-Australia. Thin sections were prepared for petrographic study in the Applied Geology Department-Kirkuk University.

Microfacies

The studied samples examined using polarized microscope to determine the petrography and the microfacies types of the lower part of Qulqula Formation in the studied section. The results of the microfacies study illustrate that mudstone – wackestone microfacies are the dominant in the studied samples. The recognised skeletal grains mainly are calcareous planktonic foraminifera, calcispheres (Figure 4D) with rare occurrence of the biserial agglutinated textularia (Figure 4C) as well as uniserial benthonic foraminifera with percentage range from 30%-50% of the skeletal grains. While green algae occurrence reported in some samples to reach 10% of the skeletal grains. The identified bioclast could reach 20% and it is mainly composed

from sponge spicules, pelecypods and gastropods shells, while lithoclast, pellets and ooids reaches 10%. Cementation is common and dominated by the blocky cement type (Figure 4D). Stylolites are very common in the studied samples.

Calpionellids assemblages

The studied samples within the lower part of the Qulqula Formation revealed the identification of the calpionellids assemblages for the first time. The calpionellids are regarded one of the most cosmopolitan fossils assemblages during the Late Jurassic to Early Cretaceous [10]. It covers the entire Tethyan basin region from east Northern and Southern America in the west to Middle Asia in the east [11]. Two species were recognised in the studied samples from the lower part of Qulqula Formation which includes; *Tintinnopsella remanei* Borza, (Figure 4A), described from the Late Tithonian and *Calpionellites major* (Colom), (Figure 4B), well described from the Early Valanginian [12; [13]; [14]; [15]; [16]. Thus, the studied section of lower Qulqula Formation represents the Late Tithonian – Early Valanginian (i.e. Late Jurassic - Early Cretaceous).

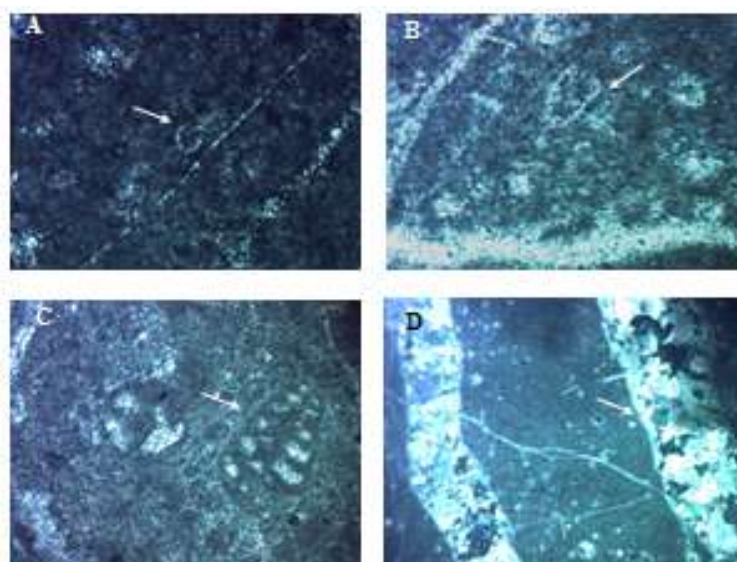


Figure 4. Calpionellids assemblages as described in this study. A. *Tintinnopsella remanei* Borza in wackestone microfacies, X40; B. *Calpionellites major* (Colom), X100; C. Biseriate foraminifera in recrystallized matrix, X40; and D. Blocky cement with calcispheres (bright circles) in the matrix, X40. White arrows to indicate features.

Mineralogy

The mineralogical results (Figures 5 & 6) of the studied samples show that the main minerals constituent is quartz (chert), calcite, aragonite and high Mg calcite (Table 1). On the other hand, the identified clay minerals include kaolinite, mixed layer illite and mica minerals. While other minerals are recorded which includes gypsum, glauconite and scarce of anhydrite. This represent the diagenesis results and the authigenic minerals formation within the lower part of Qulqula Formation.

Table 1. X-ray diffraction analysis results for the studied carbonate sample. The high silica content related to the chert occurrences. Minerals presented in weight percent.

No.	Mineral	Weight%
1	Anhydrite	0.4
2	Aragonite	3.7
3	Calcite	18.6
4	Glauconite	2.5
5	Gypsum	3.2
6	High Mg Calcite	2.6
7	Mixed layer illite	3.4
8	Kaolinite	2
9	Mica	2.3
10	Quartz	61.3

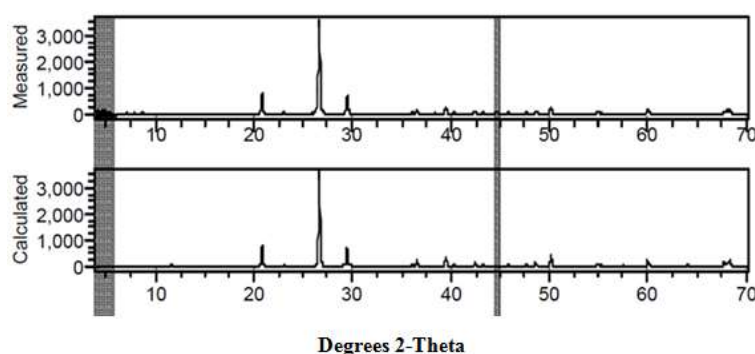


Figure 5. X-ray diffraction results, the calculated and the measured peaks are provided for comparison.

Conclusions

The microfacies study shows that the studied samples were mudstone to wackestone. Fossils content

includes planktonic foraminifera with ratios 30%-50% of the grains, with occasional occurrence of calcispheres and biserial benthonic foraminifera.

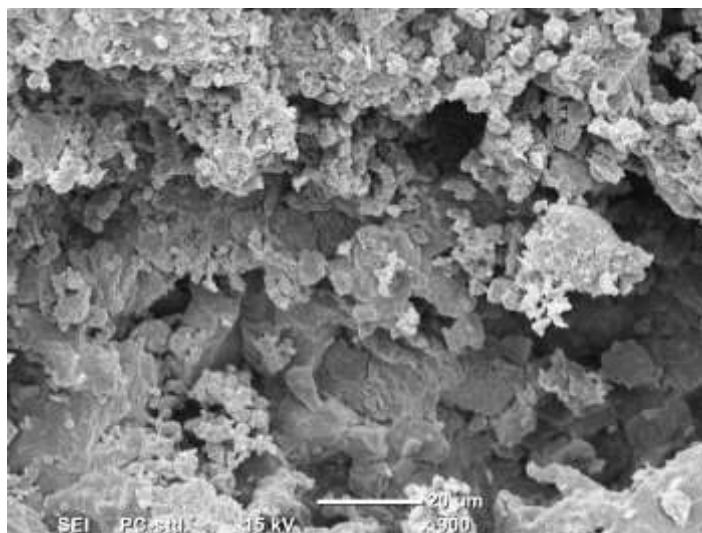


Figure 6. Scanning electron microscope image of recrystallized calcite.

Bioclast ratio reaches maximum 30%, sponge spicules, pelecypods and gastropods shells are the main identified bioclast. On the other hand, lithoclast and pelloid reported maximum 30% and 20 % respectively. Additionally, blocky calcite cement is the dominant cement type recognised in the studied samples. Additionally, most porosity are plugged with cement material and the samples are severely recrystallized and partly dolomitized.

Further, the main minerals contents of the studied sample were quartz (chert), calcite, aragonite and

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دراسة طباقية تكوين قفلة، السليمانية - شمال شرق العراق

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الملخص

تم دراسة تكوين قفلة في جبل سورين - السليمانية - شمال شرق العراق، وجمعت عشرة نماذج من المقطع المدروس بالقرب من منطقة كاني سيف حامد. درست النماذج بتروغرافيا ومعدنيا باستخدام تقنية الاشعة السينية الحدية والمجهر الالكتروني الماسح مع تقنية مطيافية تشتت الطاقة بالأشعة السينية. تم تحضير النماذج والتحليل بجامعة وولونغونغ - استراليا. اظهرت النتائج الاولى ان صخور تكوين قفلة في المقطع المدروس تعرضت لعملية اعادة تبلور ودلمة جزئية. زمنياً، فان تكوين قفلة في المقطع المدروس كان يعتقد انه بعمر الترياسي المتأخر. اثبتت الدراسة الحالية وللمرة الاولى تواجد حشود متحجرات الكالبيونيلىدس ضمن الجزء السفلي المدروس من تكوين قفلة اذ تم تشخيص النوعين *Calpionellites major* (Colom) و *Tintinnopsella remanei* Borza الدالين على الجوراسيك المتأخر - الكريتاسي المبكر (التثونيان المتأخر - الفالاتجنيان المبكر بالتعاقب). هذه النتائج هي متوافقة مع ما هو منشور من تحديد عمر التكوين في الدراسات السابقة.