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NEW IDEAS ABOUT GULNERI SHALE FORMATION (EARLY TURONIAN) IN DOKAN AREA, KURDISTAN REGION, NE IRAQ

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ABSTRACT

Gulneri Formation (Early Turonian) consists, mainly as previously described, of shale deposited in euxinic and small relic basin. In the present study, it was found that it consists mainly of marl and marly limestone with no more than 20% of laminated shale. Thin section study showed that the shale is highly deformed, which has foliation-like texture. Therefore, most probably the previously described shale is originally marl, which is changed to laminated shale-like rock, by pressure that released insoluble residue and bitumen materials from surrounding rocks. By filtering of these materials, the marl was changed to black shale-like rock. The effect of the pressure is observed by bending of the shale laminae around the spherical limestone bodies and the flattening of planktonic foraminifera to elongated shape.

The upper and lower contacts of the Gulneri Formation seem to be conformable; as conglomerates,, erosional surfaces and paleosols were not found. But, the short duration of possible submarine erosion or slow rate of deposition is not excluded. There are spherical limestone bodies in the formation and near the contacts, but they are not conglomerate; as assumed previously. Field and thin section studies reveled that the bodies are ball and pillow structures, which are formed by pressure; this is evidenced by the absence of silt and sand size grains in the ball and pillow-like structures. This formation occurs only in Dokan dam site and it does not exist in near by surrounding areas. Therefore, we suggest combining it with Kometan Formation.

افكار جديدة حول تكوين كولنيري (تورونيان المبكر)

في منطقة دوكان ،أقليم كردستان، شمال شرق العراق

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ألمستخلص

يتكون تكوين الكولنيري (تورونيان المبكر) بشكل رئيسي ، كما مذكور سابقة ، من السجيل وقد ترسب في حوض اختزالي متبقي وصغير. إستنتج في الدراسة الحالية بأنه يتكون بشكل رئيسي, من الطفل و الحجر الجيري الطفلي و نسبة السجيل الصفائحي لا تتجاوز 20% من سمك التكوين . اظهرت دراسة الشرائح الرقيقة بان السجيل مشوه جدا و نسيجه يشبه النسيج الصفائحي في الصخور المتحولة. لذلك من المحتمل ان السجيل اصله طفل وتحول الى السجيل الصفائحي بواسطة الضغط ، حيث ادى الى انطلاق المحاليل الحاوية على المواد غير المذابة والمواد العضوية من الصخور المجاورة وبواسطة الترشيح تحول الطفل الى صخرة سوداء ذات مظهر السجيل . و يمكن ملاحظة اثار الضغط من تكور السجيل الصفائحي حول الاجسام الكروية للحجر الجيري وكذالك تغير شكل الفورامنفرا الى اشكال طولية.

ان الحدين العلوي والسفلي للتكوين الكولنيري يظهران توافقيا، حيث لم تشاهد المدملكات او التربة القديمة او اسطح التعرية، ولكن لا نستبعد التعرية الجزئية تحت البحرية او عدم الترسيب لفترات قصيرة. اظهرت الدراسة الحقلية تواجد تراكيب كروية و وسائدية ذات احجام الجلاميد و الحصوات في التكوين ، حيث تشكلت بواسطة الضغط وهي ليست مدملكات وكما ذكرت سابقاً. والدليل على هذا هو ان كل الاجسام لها نفس عمر التكوين وخاليه من الحبيبات الفتاتية من حجم الرمل و الغرين. يكتشف هذا التكوين في موقع سد دوكان فقط ، وغير موجود في اماكن قريبة وبعيدة منها. لذلك نقترح بان يدمج هذا التكوين مع تكوين الكوميتان.

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INTRODUCTION

The Gulneri Formation was first described by Lancaster Jones (1957) in Bellen *et al*.(1959) from the Dokan Dam site, in the High Folded Zone (Figs.1 and 2), where it consists of about 2 m of black, bituminous, finely laminated, calcareous shale with some glauconite and collophane at the lower part.. The age of the formation is Early Turonian (Bellen *et al*., 1959). They also cited that in some reports of Dokan Dam it is mentioned as Shiranish Shale.

The high bitumen content and dwarfed fossils indicate that the Gulneri Formation was deposited in a euxinic environment (Jassim and Buday in Jassim and Goff, 2006). The formation is separated by unconformities with both the overlying and the underlying Kometan and Dokan formations, respectively (Buday, 1980). According to Abawi *et al.,* (2006) eight planktonic and six benthonic foraminiferal species were recorded from the type section of Gulneri Formation at the site of Dokan Dam, indicating an Early Turonian age. The distribution of the formation is almost unknown. It crops out only around the type area and was struck in the borehole Kirkuk oil well (K 116) on the Avanah dome. Fossils were found relatively rich.

The Late Cretaceous subsurface sections in Kirkuk oil well (K 117) and Jambur oil well (13) has been studied micropaleontologically by Abawi and Hammoudi (1997). They included Gulneri Formation in the Lower part of the *Marginotruncana sigali* Zone of Late Turonain age and Kometan Formation in the upper part of the *Marginotruncana sigali*, the *Dicarinella primitive*, the *Dicarinella concavata*, the *Rosita fornicata* and the *Globotruncaita elevata* Zones, which range in age from Late Turonian to Early Campanian, a local unconformity separates the two formations from each other.

The aim of this study is to reveal the characteristics of the Gulneri Formation, concerning the sedimentology and stratigraphy. Therefore, all outcrop sections were inspected around the Dokan dam site (type area), in addition to the area around Pira Magroon, Qara Sard and Safeen anticlines (Fig.3). Both underlying and overlying contacts of the formations are given special attention and accurately examined. In the present study only three sections were found to be representative of the studied area (Fig.3). In these areas tens of sections are inspected by necked eye and hand lens, and suitable samples were collected for laboratory studies. Thin sections were studied under the microscope, polarized and fluorescent microscopes. Within all studied areas, the formation was found only in one locality, which is located directly to the south of Dokan Dam site (Fig.4).

THE NATURE OF GULNERI CONTACTS

Bellen, *et al.* (1959) mentioned that unconformable contact of Gulneri Formation with the underlying Dokan Formation at the dam site, is represented by the occurrence of micro-conglomerate.. According to Buday (1980), a thin bituminous shale unit of Early Turonian age is bounded at the top and bottom by erosional unconformities. He mentioned that these unconformities can be found locally around Dokan area and in I.P.C. oil well (K 116). This shale intervenes between the Kometan and the Cenomanian oligosteginal limestone unit. The Cenomanian oligosteginal unit is defined as the Dokan limestone and the thin Turonian shale recognized in the nomenclature as the Gulneri Shale. He added that they were perhaps preserved from Early Turonian erosion only in slight depressions in the erosional surface, which terminates the Qamchuqa Formation.

In this study, the unconformable boundary is not ascertained. This is because neither conglomerate nor karstification and paleosol were found, when the type section and surrounding areas were inspected

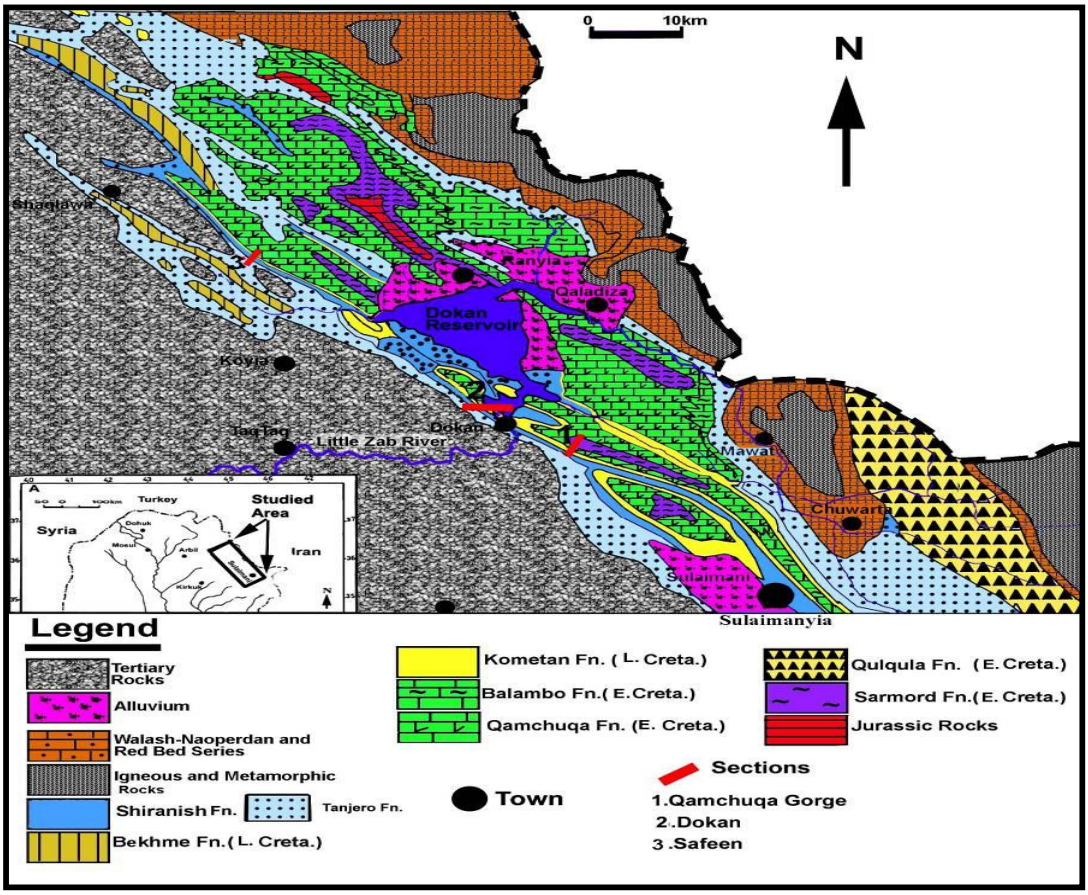

Fig.1: Geological map of the studied area and location of the sections (Modified from Sissakian, 2000).

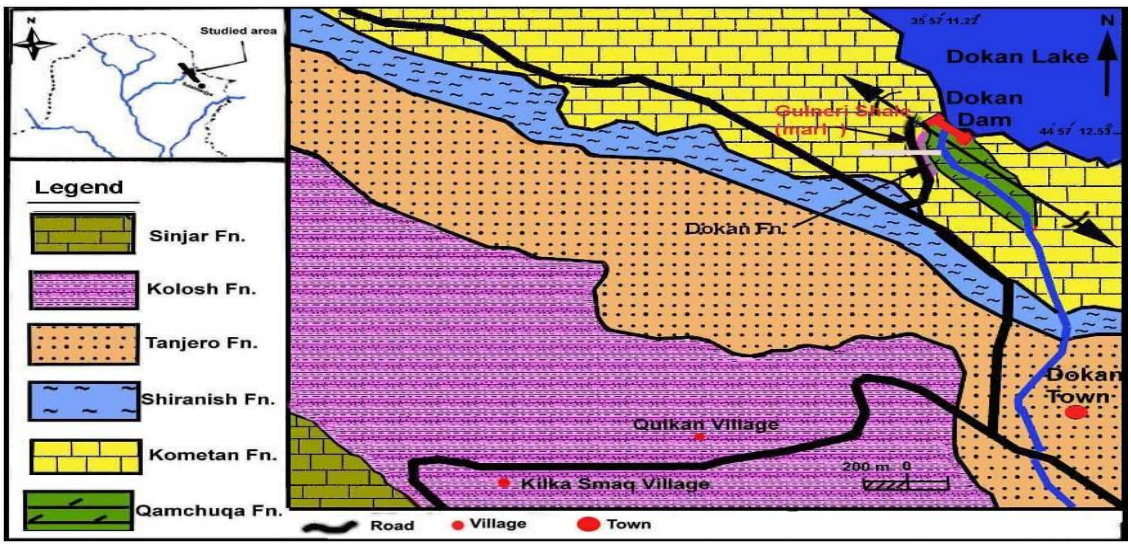

Fig.2: Simplified geological map of the type area of the Gulneri Shale Formation shows Dokan dam and Dokan section

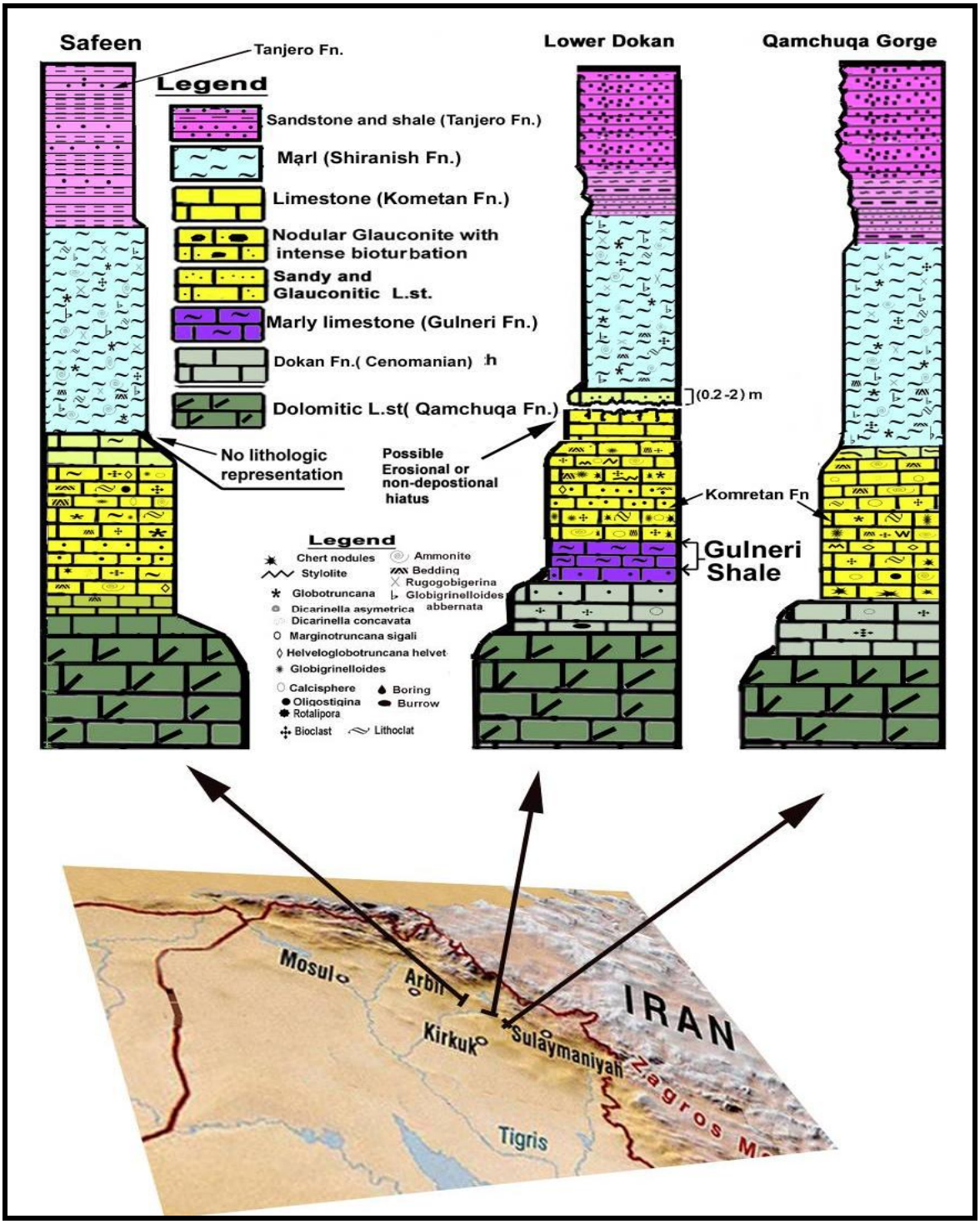

Fig.3: Stratigraphic column of the three studied outcrop sections and their location on simplified map of the northern Iraq in which the formation appears only in the type section (Lower Dokan)

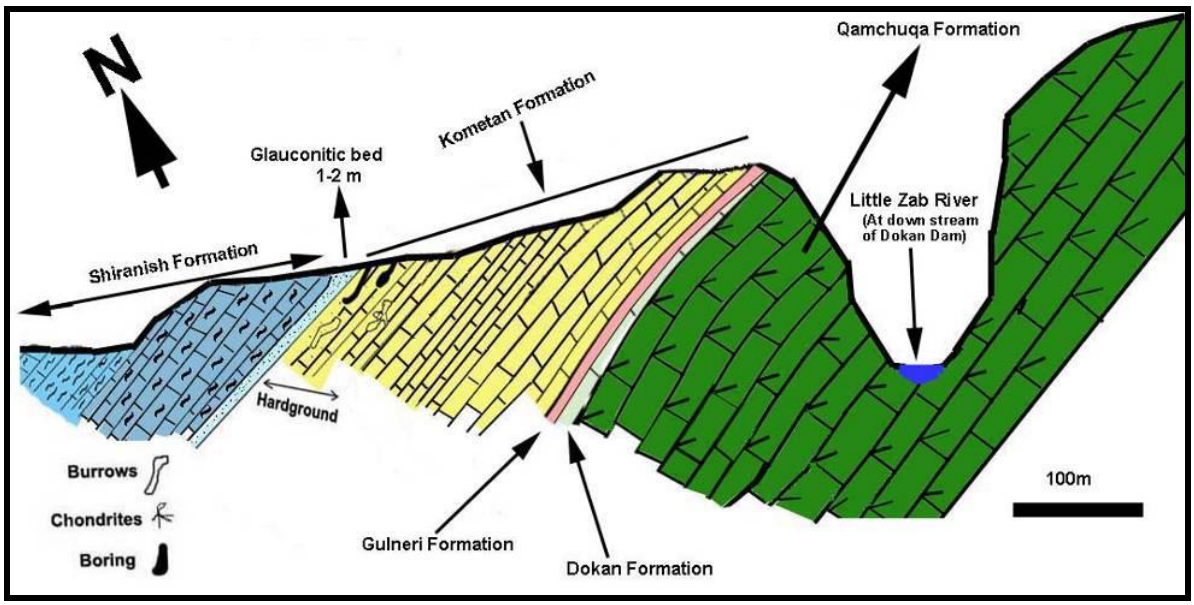

Fig. 4: Schematics geologic cross section (NE–SW) in the Dokan Gorge
(Directly to the south of the dam site)

This Gulneri Formation contains boulders and gravels-like limestone masses, directly to the south of the Dokan dam site (Figs. 5 and 6). These masses have hummocky smooth surface and bounded by highly deformed dark color shale–like materials, but are finely laminated or foliated (Fig.6). The masses have low sphericity and high roundness, which are not associated with terrigenous or intraformational sand-sized lithoclast or bioclasts. Therefore, these masses, which are assigned previously as conglomerate by Bellen *et al.* (1959) and Buday (1980), are most possibly, in our opinion, nothing except ball and pillow-like structures, which are formed by pressure. The origin of these structures are discussed in detail by Karim (2006), he found them in competent and incompetent beds. Reading (1985, p.15) and Einsele (2000) mentioned that the nodular shaly limestone is formed on the carbonate platform during drowning. This is applicable for Gulneri Formation, as Taha (2008) assigned it as sediments of drowning phase, which means deepening not uplifting and erosion, as interpreted by Bellen *et al.* (1959) and Buday (1980).

The aforementioned masses, ball and pillow-like structures, all have the same age of the Gulneri Formation (Early Turonian) and consist of the same lithology (fine crystalline limestone with same species of forams species). These masses if to have prerequisites as conglomerate, then must be associated with terrigenous or intraformational clastics, such as sand and bioclastic grains, but no such grains were found. The recent age determination did not refer to gaps in sedimentations as Al-Shdidi *et al*. (1995) indicated Late Cenomanian age of Dokan Formation, while the age of Gulneri Formation is Early Turonian as recorded by Abawi *et al.* (2006). The recorded deep water planktonic foraminifera,, by later authors, emphasizes the absence of unconformity. A slight sharpness of the upper and lower contacts is observed only in one locality (Fig.7) in other localities around Dokan Dam site, the contact is gradational. According to these facts, the boundary of the Gulneri Formation has not suffered from uplift and subaerial erosion. However, this study does not exclude submarine erosion, which most possibly occurred during drowning of the Qamchuqa and Dokan formations.

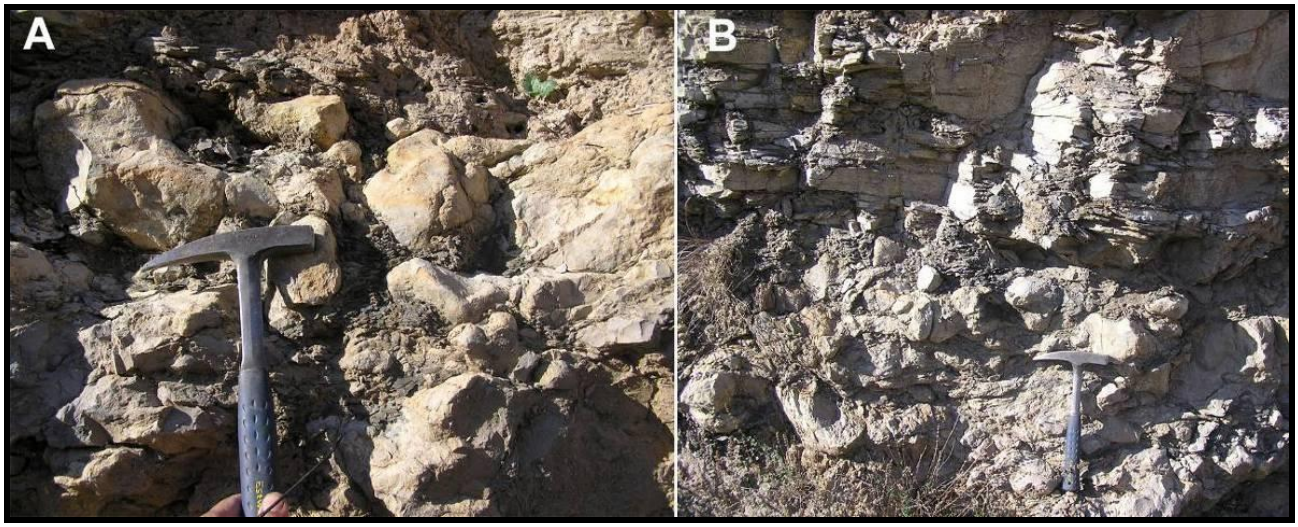

Fig.5: Close up photos of the Gulneri Formation,
show boulder and gravel-like masses of limestone.
These masses are associated with marl but do not contain sand size and bioclasts grains.

Fig.6: **Left:** Limestone (L), marly limestone (ML) and Black shale (BS)
some limestones are changed to pillow (PL).
Right: effect of pressure on the limestone that changed to pillow mass;
some of which are bending around others

The sharp contacts (almost) of Gulneri Formation with both underlying and overlying formations might be argued as unconformable by others. If this is true, then unsolvable problem will arise, because many formations contain tens of beds or packages of beds that are bounded by very clear sharp contacts, such as Injana, Fat`ha, Kolosh, Khurmala and Tanjero formations. The sharp contact could be generated by short duration of tsunami, hurricane, typhoon, storm and submarine current or environment changes.

Tucker (1991, p.129) mentioned that many gradational bed boundaries, may become sharp especially when limestone passes up into mud rocks. He added that in many limestone platforms, the bedding plane is not primary depositional surfaces, but they have been produced by pressure solution during burial. This hold good for the boundary of the Gulneri Formation.

Off the Dokan dam site, the Gulneri Formation disappears and changes to thinly bedded and fine crystalline limestone, such as in Boko Zaw Gorge, 3 Km northeast of the type section and north of Lower Dokan Town, 2 Km to the south of the type section (Figs.7, 8 and 9). This is true for Tabeen Gorge and both sides of Qarasard anticline, northeast and east of the dam, respectively.

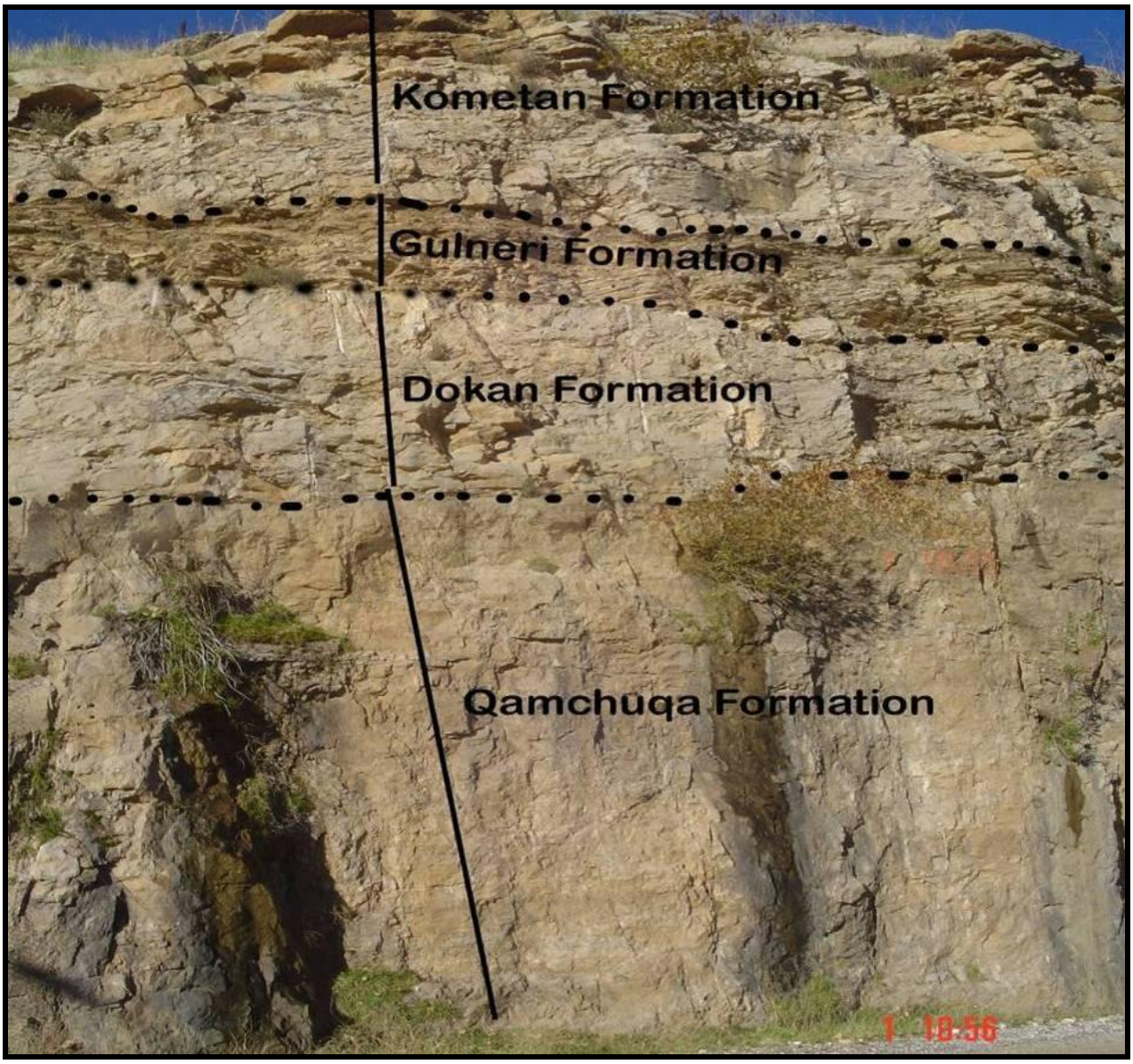

Fig. 7: Road cut cliff about 15m high, directly to the south of Dokan Dam shows the stratigraphy of the studied section

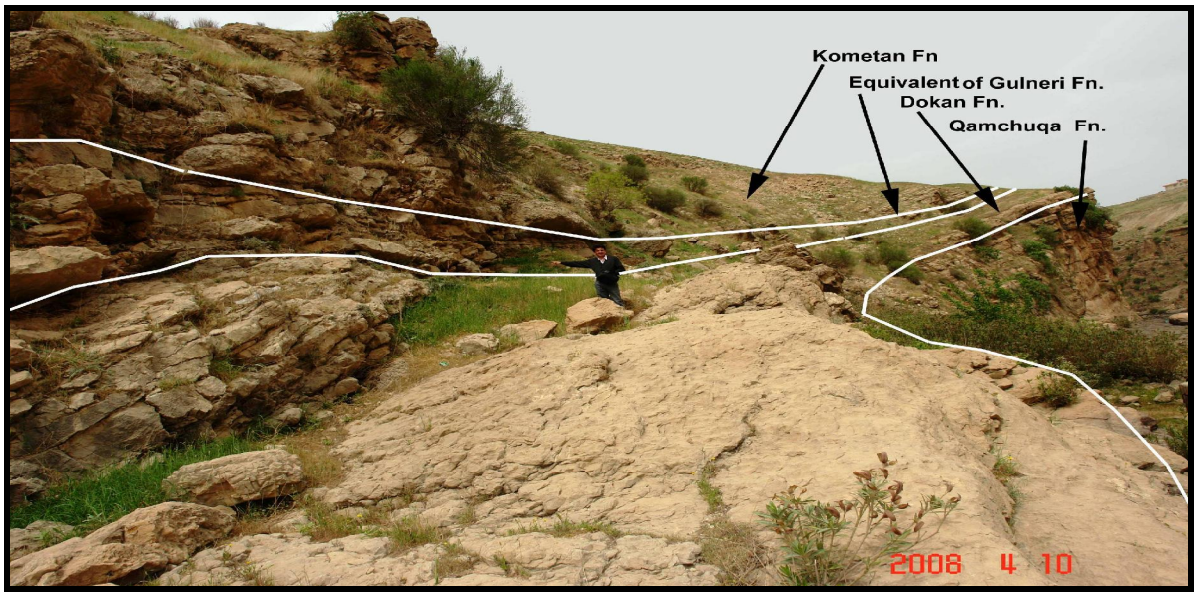

Fig.8: Equivalent of the Gulneri and Dokan formations,
down stream valley of the Lesser Zab River, 500 m north of Lower Dokan Town.

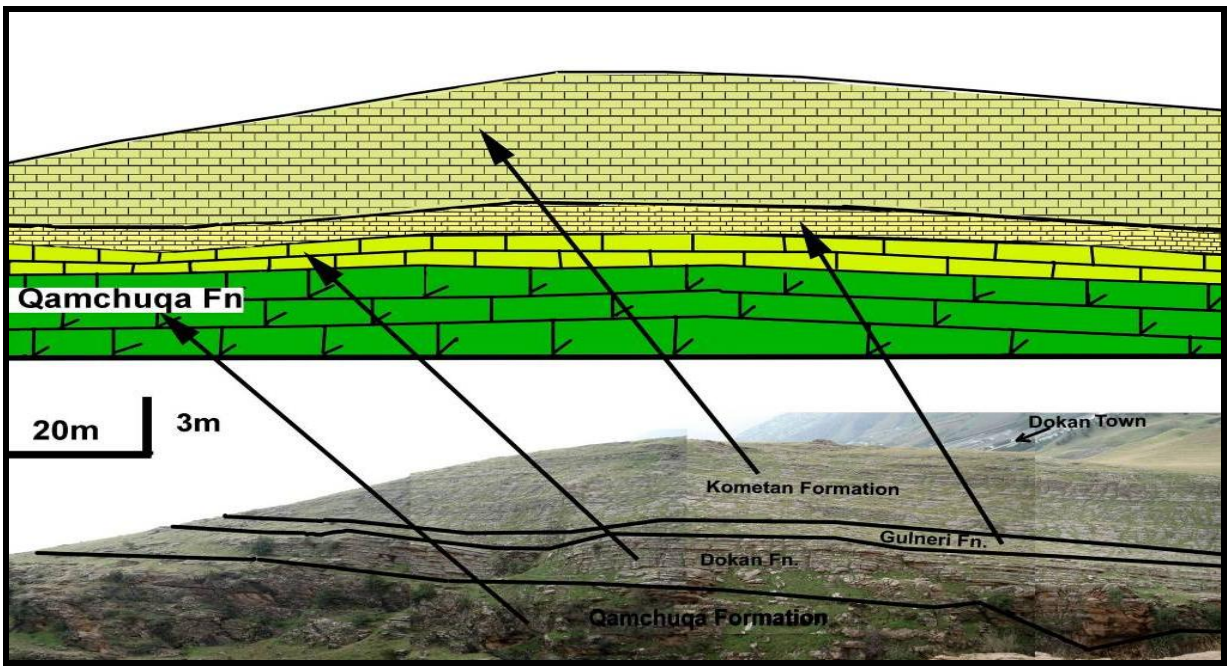

Fig.9: The Dokan and Gulneri formations;
disappear laterally in the surrounding of their type section.
but their equivalent yet can be found in the Buko Zawa Gorge,
3 Km northwest of Dokan Dam site.

PETROGRAPHY OF THE GULNERI FORMATION

The problem of the Gulneri Formation, being shale or marly limestone can be known from field and thin section studies. Bellen *et al.* (1959); Buday (1980) and Abdulla (2008) have mentioned that, in Dokan Dam site, the formation consists of about 2 m of black, bituminous, thinly laminated, calcareous shale, with some glauconite and collophane at the lower part.

In the present study, the following four facts are inferred about the formation:

First, the field and thin sections study showed that the formation, in the dam site (type locality) contain only about 20% of the shale-like lithologies. The rest (about 80%) is composed of limestone and marly limestone with some marls and glauconite (Figs. 4 and 5).

Second, the previously mentioned shale, which reaches about 20% of the total thickness of the formation, contains high content of planktonic formas (Fig.10). This high content of forams is not normal for a shale as there is no, in literature, any citation of this type of concentration of planktonic forams in shale. Potter, *et al* (1980) gave the following percentages for average shale mineral constituents: 58%, 28%, 6%, 5%, 2%, for clay minerals, quartz, feldspar, carbonate and iron oxides, respectively. These percentages are not recorded in so called “shale” in Gulneri "Shale" Formation. Some samples are studied under normal light and fluorescent microscopes for identifying organic materials. These materials include: Alginite, Leptodetrinite, Bituminite, Organo mineral complex and Organic amorphous particles (Table1). According to organic petrology these organic minerals are of secondary and migrated into the formation (P.A. Khanaqa, personal communication, 2008).

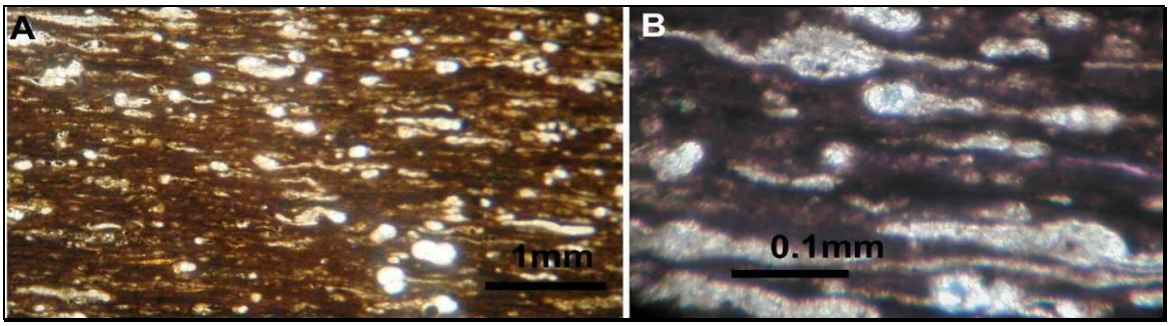

Fig.10: Two thin section photos showing intense effect pressure on the marly limestone by which the planktonic forams are flattened and arranged it parallels to bedding plane.

Table (1) Classification of the Organic matter in Gulneri Formation under normal and fluorescent microscope.

Under normal light microscope	Under Fluoresces microscope
1.Alginite (colorless if aggregate but yellow if single) 2.Leptodetrinite (like as Alginite) 3.Bituminite (colorless) 4.Organo mineral complex (brown) 5.Organic amorphous particles (dark) 6.Foraminifera (colorless)	1.Alginite (pale yellow) 2.Leptodetrinite (pale yellow and brown) 3.Bituminite (dark brown to pale brown) 4.Organo mineral complex (dark brown) 5.Organic amorphous particles (dark) 6.Foraminifera (blue)

Third, the so called " 20% shale" exists, in outcrops, as bended laminae, as black and hard rocks, around limestone pillow-like bodies (nodules) (Figs. 5 and 6). They appear, in thin section, as black highly deformed rock. The deformation is so intense that the laminae appear under microscope as schistose rocks as they have foliation-like texture and the globular forams are deformed to elongate shape (Fig.10). These features show that these laminae are formed by pressure through dissolution of limestone and migration of bitumen. The materials (insoluble residue and bitumen) are accumulated in the marl and during compaction transformed to dark laminae that obtained shale-like rocks appearance and concentrated around the limestone pillows during intense deformation. This is confirmed by occurrence of cast and mold of limestone bodies inside the formation (Figs. 5 and 6). This process is discussed by Walness (1979) through which dark color solution seams are generated by pressure.

Fourth, the ratio of insoluble residue in the dark laminae is not more than 25 % of the bulk of the samples. This ratio lies in the field of the limestone when the constituents are plotted on the compositional triangle of Laresen and Heald (1977) in Potter et *al*, (1980).

As nodular limestone is concerned, which is characteristic of Gulneri Shale, Nicholes (1999) mentioned that the extreme pressure solution and stylolitization result in loss of most of the calcium carbonate, leaving only isolated nodules of limestone in a wavy-bedding mudstone. Nodular limestone of this type is likely to have contains of high proportion of insoluble clay, either disseminated throughout the rock, or more commonly concentrated into mud rich layer. He added that pressure solution tends to highlight irregular distributions of clay and limestone. Therefore, in our estimate, the thin packages of laminae of shale and nodules in Gulneri shale are formed by the processes described above by Nichols (1999).

According to the mentioned facts and concerning of stratigraphy and rules of formations recognition, it is convenient to combine Gulneri Formation with the overlying Kometan Formation, because it is not mappable due to its very thin thickness and very short lateral extends.

CONCLUSIONS

This study concluded the followings:

- The Gulneri Formation contains minor shale (less than 20%) and mainly consists of marl and marly limestone, which is changed to ball and pillow-like structures by lithostatic pressure during burial.
- The shale lamina are originally marl, which are changed to shale –like rocks by pressure, solution and impregnation by bitumen.
- Geographically, the formation has short lateral extend in the studied area and can be seen only along road cut near the Dokan Dam. Outside the dam and in all directions it changes to fine crystalline limestone (Kometan Formation).
- The lithology and distribution of the Gulneri Formation show that it is better to combine the formation with the overlying Kometan Formation, in the studied area.

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