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Overview of the Triassic System in Syria: Lithostratigraphic and biostratigraphic correlations with neighboring areas

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ABSTRACT

Biostratigraphic data provide evidence of the presence of Triassic sedimentary successions in the main mountain belts in Syria. The study of the sedimentary successions in these chains and in the main deep wells lead to a new subdivision of the Triassic in Syria into four lithological units/formations: (1) The lower Habari Formation is clastic and Scythian to Early Anisian in age. (2) The overlying Abu Fayad Formation is generally carbonaceous, Late Anisian to Ladinian in age, and subdivided into three members. (3) The Hayan Formation is mainly evaporitic and Carnian – Norian in age. (4) The upper Safa Formation is generally carbonaceous, with some marl intercalations and thin evaporite beds. and Norian to ?Rhaetian in age. These lithological formations extend over the entire northern Arabian platform with very characteristic and distinguishable facies, rendering their correlation within Syria and to their equivalents in neighboring countries straightforward. Moreover, lateral facies changes in these formations enabled establishing a geological and paleogeographical evolution of Syria and the surrounding areas during the Triassic Period. This evolution revealed the presence of two NE-elongated Triassic paleostructures: Hamad Uplift in the south and Aleppo-Mardine High in the north, which separate the Palmyride Basin from the Rutbah Basin in the south, and the Palmyride Basin from the Ifrine Basin in the north, respectively.

INTRODUCTION

The first evidence for the occurrence of Triassic rocks in Syria was mentioned by Dubertret (1937) in exotic allochthonous blocks obducted within the ophiolitic complex onto northwest Syria. These scattered blocks are composed of compact grey sandy limestone becoming in places grey thinly laminated limestone, with *Halobia parceltica* Kittl, *H. norica* Mojs, or *H. plicosa* Mojs, and *Daonella imperialis* Kittl. Further studies demonstrated the presence of Triassic rocks in Syria's major ranges in, for example, the Palmyrides (Mouty, 1976; BRGM, 1977, Mouty and Al-Maleh, 1983, 1997a), the Coastal Chain (Jibal As-Sahilyeh) (Mouty, 1997b) and the Mount Hermon (Anti-Lebanon) (Mouty and Zaninetti, 1998; Mouty, 2000) (Figure 1).

Oil and gas exploration wells penetrated Triassic formations in different parts of Syria providing valuable data, which enhanced the knowledge of this period. At least two lithological terminologies were used to describe the subsurface Triassic section. The first was formally defined in Syria, while the other was adopted from northern Iraq. Syrian petroleum geologists abandoned the Syrian terms in favor of Iraq's in order to establish better and easier correlations between lithostratigraphic formations, which usually lacked biostratigraphic markers. After the discovery of oil and gas in clastic reservoirs in the Euphrates Graben area during the 1980s, a specific terminology was established for that particular area by the petroleum operators (SPC, the Syrian Petroleum Company, AFPC with Shell and DEZPC with Elf and Total). There the entire Triassic section was named "Mulussa" with a local sequence definition between Mulussa A (Scythian) and Mulussa H (Rhaetian to Lower Jurassic) (Jamal et al., 2000). Figure 2 shows the established subdivisions of the Triassic successions of Syria, their age and their correlations with neighboring countries.

Later studies, carried out on the Triassic successions in Syria, demonstrated discrepancies between the Syrian petroleum geologists' reference chart and those defined in other countries, in particular Iraq. This led to confusion and occasionally to erroneous lithostratigraphic correlations (Bach Imam and

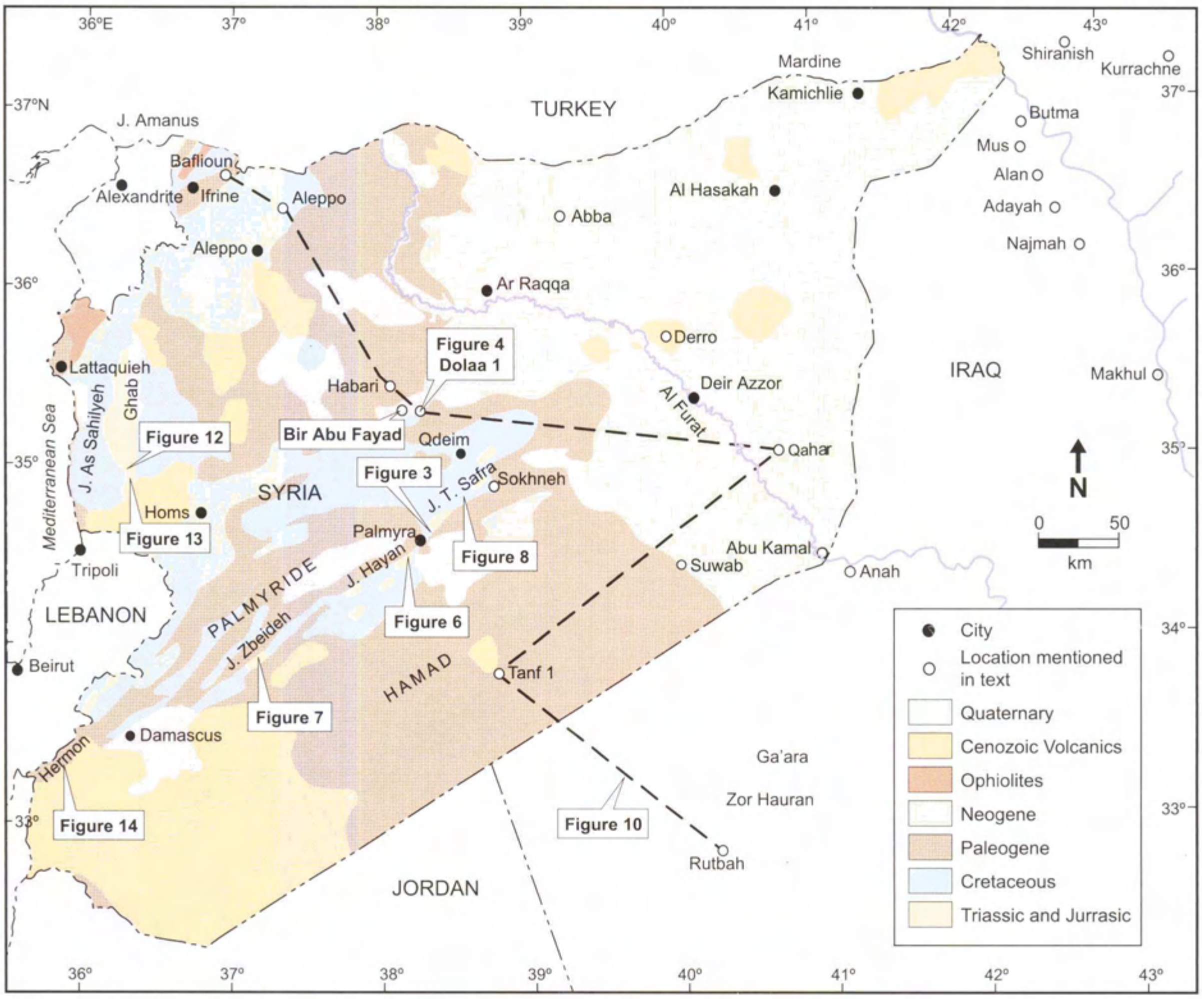

Figure 1: Schematic geological map of Syria (after Ponikarov, 1966) showing the type localities of Triassic formations in the region.

Sigal, 1985; Kammar, 1994). Moreover this left doubts on the validity of earlier correlations conducted by petroleum geologists between Syrian lithological units and Iraqi charts.

The first objective of this paper is to review all the subdivisions of Syrian Triassic successions made by different workers in order to establish a local stratigraphic subdivision based on numerous lithological, macro- and micropaleontologic criteria. The second objective is to correlate Triassic formations and lithological units within Syria and with those in neighboring countries, and to improve the understanding of the paleogeography of the northern Arabian Platform during the Triassic Period.

STRATIGRAPHY AND SUBDIVISIONS

Outcropping Triassic rocks in the cores of the major Syrian ranges do not show the entire Triassic section. Hence, studying complete Triassic successions is mainly based on subsurface data. The Palmyrides Belt is the most favorable area to establish a Triassic subdivision for all of Syria, due to the numerous borehole penetrations, and to the common exposure of Upper Triassic successions in the Palmyrides anticlines (Figure 3).

The first Triassic-penetrating reference well used in this study is Dolaa 1 drilled by SPC in 1948, about 78 km north of Palmyra (Syria) at 35°15′40″N and 38°20″09′E (rotary table elevation 491 m above sea level; Figure 1). There, for the first time, Dubertret and Daniel (1962) and Daniel (1963) described and subdivided the Triassic successions into five lithostratigraphic units. This subdivision differs from the

Locality / Age	SYRIA: Ancient		SYRIA: Syria Petroleum Company	SYRIA: Kammar (1994)		SYRIA: TOTAL Jamal et al. (2000)		SYRIA: This Study	IRAQ: South-west	IRAQ: North-west	IRAQ: North	JORDAN: W. Zarka	PALES-TINE: W. Ramon
Late and Mid Jurassic	Dolaa Group	I	Qamchuqa	Mulussa	H	Mulussa	H	Satih	Muhaiwir	Sargelu	Sargelu Sekha-nian	Subehi	Mishor
Rhaetian			Sargelu Alan Mus Adaya Butma		G F E D		G F	Safa	Ubaid	Alan Mus Adayah Butma	Sarki	Zarqa	Shefayim
Norian		II	Kurrachine Anhydrite		C		E	Hayan	Zor Hauran	Balluti	Balluti		Mohilla
Carnian							D						
Ladinian		III	Kurrachine Dolomite		B		C	Abu Fayad	Mulussa	Kurra-chine	Kurra-chine	Hisban	Saha-ronim
Anisian		IV V					B				Gelikhana	Humrat Main	Gevanim Ra'af
Scythian	Doubayat Group	I	Amanus Shale		A		A	Habari			Beduh Mirga Mir		Zafir Yamin
Late Permian		II	Amanus Sandstone					Qdeim	Ga'ara		Chia Zairi		Argov

Figure 2: Correlation between formations and units in Syria and in neighboring countries. See Figure 1 for location.

Triassic subdivisions in Iraq, which was later adopted by Syrian petroleum geologists for describing almost all major wells in Syria. This difference is outstanding when comparing two very close wells in the middle of the Palmyride Basin, namely Dolaa 1 (drilled in 1948 by SPC, Figures 4 and 5) and Bir Abu Fayad well (drilled in 1988 by SPC), using all data cited by previous authors. The Dolaa 1 section is described according to the old Syrian Triassic subdivision (Dubertret and Daniel, 1962, Daniel, 1963), while Bir Abu Fayad well, just 15 km away to the west of Dolaa 1, was described by petroleum geologists according to the Iraqi Triassic subdivision (Kammar, 1994) (Figure 5).

Throughout this study, four lithological units are distinguished in the Syrian Triassic succession, particularly in the Palmyride Basin. They represent two major sedimentary cycles: (1) the first starts with a lower clastic unit, overlain by a calcareous carbonate one; and (2) the second is composed of an evaporitic unit overlain by an upper carbonate unit. Without specific mention in the following sections, all lithostratigraphic description refer to the well Dolaa 1.

Triassic Lower Clastic Unit: Habari Formation

This unit corresponds to Unit I of "Doubayat Group" in Dolaa 1 (Figure 4). According to Dubertret and Daniel (1962) it consists of 110 m (2,258–2,368 m below rotary table – RT) of thick black silty shale with fine grey limestone intercalations, becoming calcareous upwards. It bears the fauna assemblage *Halobia* sp., *Daonella moussoni* Sea, *Myophoria kefersteini* group, cf. *Mr. vulgaris* (Schlotheim), cf. *Hoernesia socialis* (Schlotheim), *Pseudomonotis* cf. *clarei* (Emmrich), *Gervillia angusta* (Goldfus), *Worthenia* sp.? *Estheria*, "*Orthoceras* sl, *Gonodus* sp., *Natiria gaillardoti* (Lefr), *Ceratites* cf *trinodosus* Mojs, teeth of