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# Geology of the Euphrates River with Emphasize on the Iraqi Part

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## Abstract

The Euphrates River is one of the longest rivers in Iraq with five main tributaries along its course. But without any tributary inside Iraq. The river flows from eastern highlands of Turkey then through Syria and enters into the Iraqi territory from central western part and runs westwards to the central part of Iraq and then meets with the Tigris River in the southern part. The geology of the Euphrates River's basin is presented with emphasize on the Iraqi part. Besides, the stratigraphy of the basin, the tectonic style, main geomorphological features and minerals' resources are presented within the basin too. Wide range of rocks; age wise are exposed in the basin, with different economic potentials at different parts of the basin.

This study is a unique one, which deals with the geology of the Euphrates River's basin. It is conducted using the most relevant updated geological data.

**Keywords:** Euphrates River, Tributaries, Geology, Mineral potentials

## 1 Introduction

Geological studies dealing with different parts of any river are very common; however, dealing with the whole course within the catchment basin of a certain river with its tributaries are extremely rare, especially in Iraq.

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The Euphrates River is one of the longest rivers in Southeast Asia; its length is 2786 km. Its basin area is 440000 km2 shared by five countries (Fig. 1), Iraq 47%, Turkey 28%, Syria 22%, Saudi Arabia 2.97% and Jordan 0.03%.

The geology and topography along the course of the Euphrates River and its basin are given with many satellite images and different maps for clarification purposes. However, the given details in Turkey and Syria are presented more briefly, as compared to those given in Iraq.

The aim of this study is to present the geology of the Euphrates River's basin, which extends from Turkey to Syria and Iraq, and partly in Saudi Arabia; as far as the valleys which drain to the river are concerned. The stratigraphy, tectonics and structural geology and the main geomorphological features and units are briefly mentioned with the main economic potentials; as the geology is concerned; such as oil, gas, metallic non-metallic minerals and industrial rocks.


Figure 1: Geographical map showing the Euphrates River's basin

To fulfil the aim of this study, the following materials were used:
Geological maps of different scales
Satellite images
Relevant published articles and different geological reports

Geological maps of different scales of different parts of the Euphrates River's basin were used with the help of the satellite images with different resolutions to indicate the stratigraphy, tectonics, structural geology and geomorphology of the basin. The geology of the Euphrates River within the Iraqi territory is given in details in the geological quadrangles through which the river flows at scale of 1: 250000 (Fig. 2). These are: Albu Kamal (Sissakian and Hafidh, 1994), Haditha (Sissakian, 1993), Al-Ramadi (Sissakian, 1994), Baghdad (Deikran, 1995), Karbala (Barwary and Slewa, 1995), Al-Najaf (Barwary and Slewa, 1994), Al-Nasiriya (Deikran, 1994), Souq Al-Shiyoukh (Deikran, 1993) and Al-Basra (Yacoub, 1992).

To indicate the economic potentials; as geological materials are concerned of different parts of the basin, many relevant geological reports and published articles were reviewed.

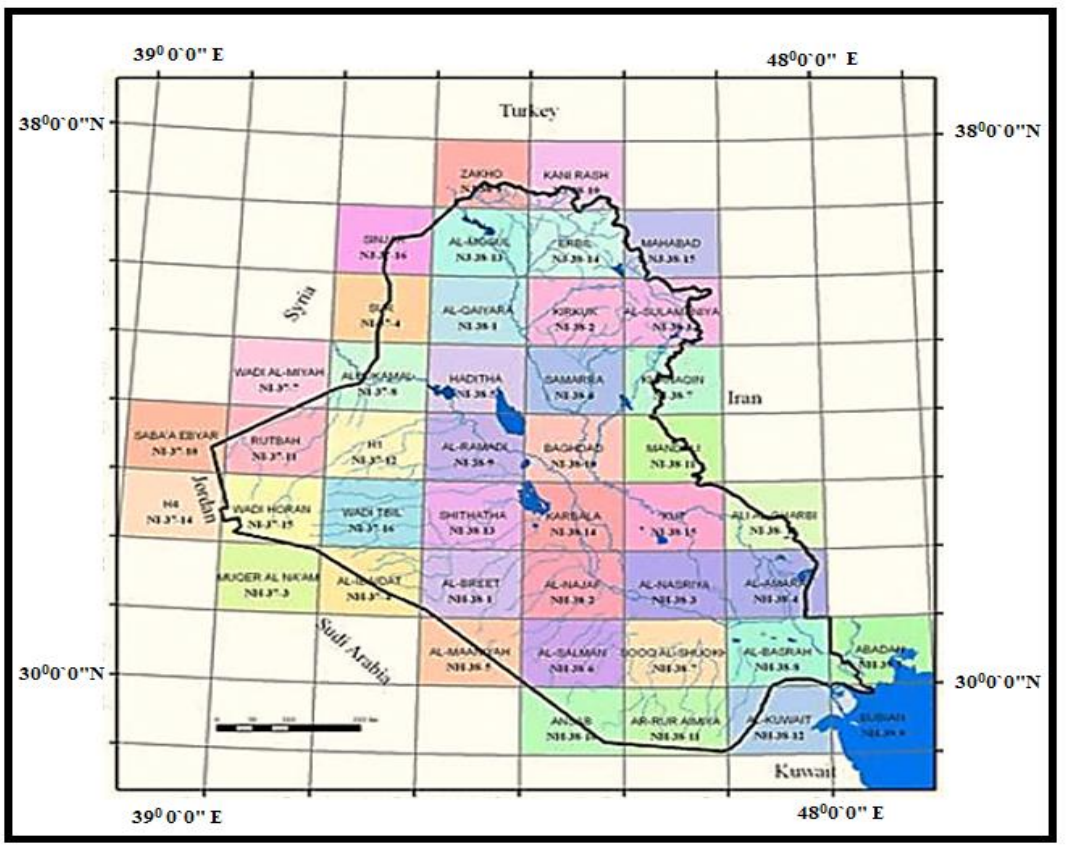

Figure 2: Index of geological maps of Iraq at scale of 1:250000

## 2 The Course of the Euphrates River

The Euphrates River inside Turkey flows in mountainous areas with almost gorge and/ or canyon like valleys; forming favourable sites for construction of many dams. The river originates in the highlands of Armenia near Erzrum city. Its headwaters tributaries are Kara Su and Murat Su. The former is known as the Western Euphrates, originates north of Erzurum city and flows westwards within the Erzurum Plateau before it merges with the Murat Su. This tributary flows westward through the Armenian Highlands and the two rivers join together near the city of Ekbazari.

The Euphrates River inside Syria flows in undulatory plains; in its upper reaches. In the central and southern parts, flows alongside some mountains and elevated areas with wide flood plains, which are the north-westwards continuations of the wide plains inside Iraq. The river has three tributaries: 1) Sajur River which is formed from the joining of two streams in Turkey the Ayfinar Deresi and the Bagırsak Deresi and it joins the Euphrates 20 km downstream of Jarablus city from the right. The length of the river is 108 km, 2) Belaikh River, the source of the water is Ain al Arous Spring near Tell Abyad. It joins the Euphrates from the left south of Raka city downstream Tabaka dam about 80 km south of the Turkish border. The length of the river is 196 km, and 3) Khabor River, it originates both in Syria and in Turkey and joins the Euphrates River south of Dier Al-Zor. Its length is 388 km of which 80 km lies in Turkey.

The Euphrates River enters from Syria into the Iraqi territory in the central western part (Fig. 1) at a town called Al-Qaim. The flood plain is wide with many acute meanders, some of them form abandoned ox bow lakes (Fig. 3).

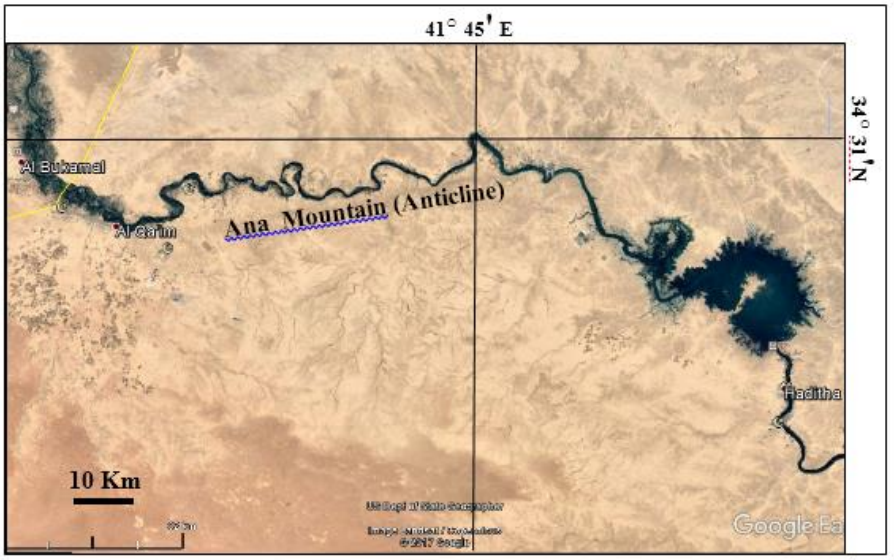


Figure 3: Google Earth image of the Euphrates River, note the wide flood plain, acute meandering, dense net of valleys, which drain into the river, and Haditha Dam Reservoir.

The valley of the Euphrates River runs through a rocky terrain, to the south is Ana Mountain, an outstanding morphological feature in the Iraqi Western Desert; whereas to the north is Al-Jazira Plain with undulatory and rolling landscapes, the trend of the river is almost W – E (Fig. 3). A dense network of valleys from the south drain the Western Desert into the river (Fig. 1). The river continues flowing in a rocky terrain until it crosses Ana Mountain, and then changes its trend to NNW – SSE until it enters into Haditha Dam Reservoir.

The Euphrates River flows out of Haditha Dam Reservoir and continues flowing in a rocky terrain with a trend of almost N – S. Many large valleys merge into the river flowing from the Iraqi Western Desert, like Hauran, which is the largest valley in Iraq (Sissakian et al., 2017 B), Al-Asadi, Al-Mahamidiyat. After 85 km from the dam, the river enters the Mesopotamian Plain, between Hit town and Ramadi city (Fig. 1).

Near to Ramadi city, an artificial channel had been constructed to divert the water to Al-Habaniyah Depression which off takes from the left bank of the river upstream Ramadi Barrage. Two more channels connect to this created lake; the first returns water to the river and the second is a flood escape outlet from Al-Habaniyah to Al-Razzazah Depression; all are in flat and rolling rocky landscapes.

After Ramadi city, the Euphrates River flows in a wide alluvial plain with tens of meanders indicating maturity of the river. Near Al-Falluja town, the Falluja Barrage was built across the river to feed the extensive irrigation canals networks extending in south-easterly direction, and also where the "Dhir'aa Al-Furat" canal merges with the river; this canal brings supplementary water from the Tharthar Lake to feeds the Euphrates River during low discharge periods. Downstream from the Falluja Barrage, the river starts flowing in NW – SE trend for about 63 km then bifurcates into two main branches; an eastern one; called Shat Al-Hilla and western one; called Shat Al-Hindiya. Both branches flow in a wide flood plain with tens of distributaries and draining channels, until about 6.5 km NW of Al-Shanafiya, there they merge together forming one main river channel.

Near Al-Shanafiya, the Euphrates River forms the boundary between the Mesopotamian Plain and the Iraqi Southern Desert and continues flowing in NW – SE trend until 11 km west of Al-Simawa city. There, the river changes its trend towards the East until Al-Simawa city and starts flowing again in NW – SE trend in the Mesopotamian Plain.

At Al-Nasiriyah city, the Euphrates River changes its trend to NNW – SSE and after 25 km it enters in the first marsh called Hor Al-Hammar, near Suq Al-Shiyoukh town. Then the Euphrates River continues its course within the marsh; eastwards until it meets with the Tigris River near Al-Qurna town (Fig.1).

The Euphrates River in its entrance to the Iraqi territory forms the contact between Al-Jazira Province and the Western Desert Province until near Ramadi city, there it flows in the Mesopotamian Province until near Al-Simawa city; where it forms the contact between the Mesopotamian Province and the Southern

Desert Province, then flows back again in the Mesopotamian Province until it meets with the Tigris River in Al-Qurna town; forming Shat Al-Arab, which flows in the Arabian Gulf (Sissakian and Fouad, 2012).

The valleys, in the Western Desert flow in S – N trend, like Akash, Al-Mana'ai, and Ratga, then their courses change to SW – NE, and then to W – E. However, east of wadi Al-Ubayidh, (Fig. 4) the trend of the valleys return to SW – NE again; starting from Wadi (valley) Al-Khir, which forms the boundary between the Western and Southern Deserts. Some of the valleys of the Western Desert originate from Saudi Arabia, like wadi Hauran and very rarely from Jordan, like wadi Al-Breem.

In the Southern Desert; some of the valleys originating from Saudi Arabia are shown in (Fig. 4). Those valleys flow in highly karstified rocks forming karst topography, which has greatly influenced the drainage system (Sissakian et al., 2012); moreover, has caused development of large depressions; such as Al-Salman Depression (Sissakian et al., 2013). Therefore, considerable amount of the flood water recharge the groundwater aquifers in the Southern Desert (Al-Jiburi and Al-Basrawi, 2015).


Fig. 4: Map showing some of the main valleys in the Western and Southern Deserts. H=Hauran, G = Al-Ghadaf, U = Al-Ubayidh, K=Al-Khir, J-Al-Jill, A= Al-Aqrawi

# 3 Geological Setting of the Euphrates River's Basin

The geological setting of the Euphrates river basin is briefly reviewed using the best available data; mainly based on the geological maps of different scales and reports compiled by the Iraq Geological Survey (GEOSURV) staff. However, in Turkey, Syria and Saudi Arabia, published geological maps and satellite images are used to present; briefly the geological data. The geological setting includes: 1) Geomorphological aspects, 2) Tectonic and structural Geology, and 3) Stratigraphy.

**- Geomorphology**

The used data for describing the geomorphological aspects inside Iraq are mainly acquired from the Geomorphological Map of Iraq (Hamza, 1997) and the Geological Map of Iraq (Sissakian and Fouad, 2012).

The Euphrates River inside Turkey flows in very rugged areas forming anticlinal ridges and erosional pediments. Many levels of terraces are developed along the course of the river and its main tributaries.

The Euphrates River inside Syria flows in undulatory plains forming mainly depositional pediments with distinct river terraces and wide flood plains.

The Geomorphological units and forms of the course of the Euphrates River inside Iraq are briefly described; hereinafter.

The main Geomorphological fluvial units of the river are the terraces and flood plain. Two levels of terraces are developed in the upper reaches of the river which continues downwards until Al-Falluja town (Hamza, 1997). Moreover, poorly developed anticlinal ridges, plateaus, erosional pediments and flat irons are developed, a good example is along the northern limb of Ana anticline near the city of Ana at the upper reach of the river in Iraq (Hamza, 2007) (Fig. 5).

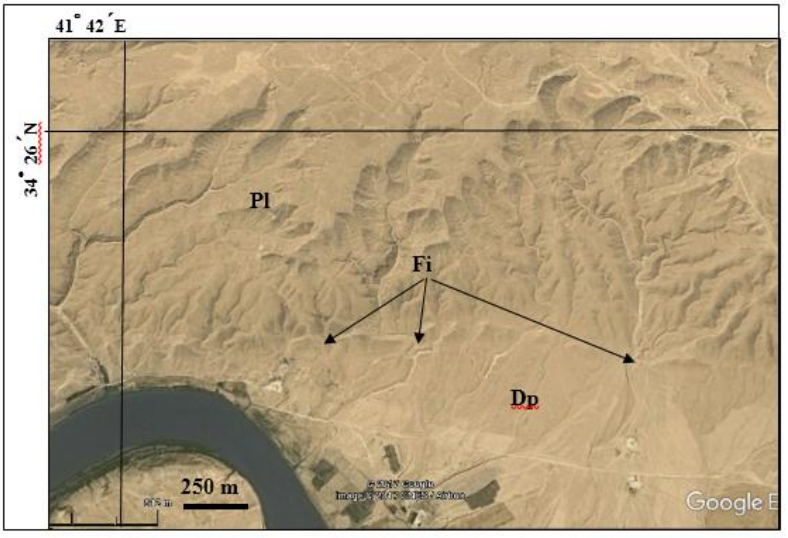


Figure 5: Google Earth image facing south, note the deeply incised valleys, plateaus (Pl), flat irons (Fi) and the depositional pediments (Dp).

Downwards from Al-Falluja, where the last terrace deposits were laid down during Pleistocene, the Euphrates River flows in a wide flood plain with tens of meanders, some of them are abandoned forming ox bow lakes and/ or are dried. After that, the river flows in the wide Mesopotamian Plain, which is characterized by depressions of different sizes, crevasse splays, sheet run off marshes (both active and dry), estuarine sabkhas sediments, and in the extreme southern part of the course of Shat Al-Arab, tidal flat and inland sabkha sediments (Yacoub, 2011**).**

**- Tectonics and Structural Geology**

The main tectonic zones of the Euphrates River's basin are described here, together with the main structural features, such as anticlines, faults, subsurface anticlines. However, the tectonic units inside Turkey, Syria and Saudi Arabia within the basin are briefly mentioned. Moreover, the neotectonic activities inside Iraq are also briefly described; emphasizing on the Mesopotamia Plain, which is a very mobile subsiding trough.

The Euphrates River inside Turkey; in its upper reaches flows mainly in the Anatolide – Turoside Block, and crosses the Northern and Eastern Anatolian faults in its northern and western reaches. Moreover, the river crosses in it is southern reaches inside Turkey the Bitlis – Zagros Suture Zone.

The Euphrates River inside Syria flows mainly in the Arabian Plate; represented by the Aleppo Plateau. In its upper reaches, it is affected by Irbid Rift; whereas in the central reach it is affected by the Palmyrides. The river in its southeastern reach; before entering into Iraq flows in the Azraq Graben, which is the continuation of the Ana Graben in Iraq.

The basin of the Euphrates River in Saudi Arabia extends along tens of large valleys, which drain the extreme southern parts of the basin (Fig. 1). The south western valleys, which form the tributaries of Wadi Hauran runs within the Interior Homocline of the Arabian Platform. Whereas, those valleys in the central southern and south eastern parts of the basin run within the Interior Platform of the Arabian Platform (Alsharhan and Narin, 1997).

The Euphrates River, where it enters the Iraqi territory from Syria, forms the contact between two tectonic zones, Al-Jazira and Western Desert zones (Fig. 6). The river flows parallel to Ana anticline in W – E trend (Fig. 6), it is the only surface anticline along the course of the river within the Iraqi territory and continues until Haditha town. There, it flows entirely within Al-Jazira Zone until west of Ramadi city. Thereafter, it flows in the Mesopotamian Zone and continues until it merges with the Tigris River. However, the Euphrates River within the Mesopotamian Zone flows almost parallel to the Abu Jir – Euphrates Fault Zone; between Al-Najaf and Al-Simawa cities (Fig. 6).

**- Neotectonics**

Although the great part of the Euphrates River's basin is located within the Stable Shelf, but still a lot of indications exist in the basin witnessing Neotectonic

activities (Sissakian and Deikran, 1998, Sissakian and Ibrahim, 2005, Sissakian et al., 2014 and 2017 A, B and C). The neotectonic indications are in form of dislocated valleys, abnormal trend and forms of valleys, dislocated valley terraces. Jebal Sanam, a salt dome is another good indication for Neotectonic activities since the rocks of the Dibdibba Formation (Pliocene – Pleistocene) are affected by the salt movements.

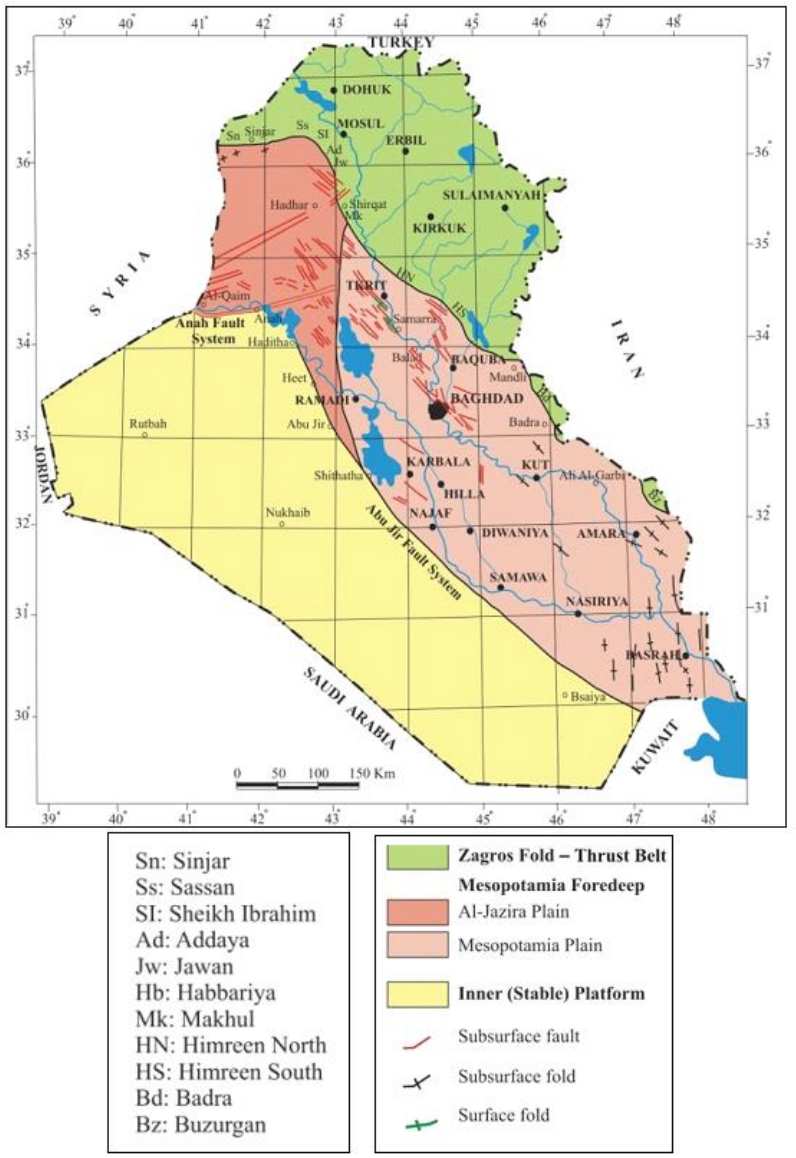


Figure 6: Structural Map of Iraq, showing the Mesopotamia Foredeep (After Fouad and Sissakian, 2011)

**- Stratigraphy**

The type, age and geological formations within the basin of the Euphrates River are described here depending on Sissakian and Fouad (2012) and Sissakian and Al-Jiburi (2007). The geological map is shown in Fig. (7). However, the exposed rocks within the basin of the river inside Turkey, Syria and Saudi Arabia are very briefly mentioned also.

The Euphrates River in Turkey, in its upper and western reaches, flows in Mesozoic metamorphic and Tertiary volcano – sedimentary rocks. South of Malatya city, the river flows in Eocene limestones and locally in Plio - Quaternary alluvial basin, until it enters to the Syrian territory.

The Euphrates River in Syria flows within the Paleogene marl and marly limestone until the central parts, then it flows in the Neogene sandstones, conglomerates and limestone, with two small volcanic necks of basalt flows northwest of Der Az Zor.

The Euphrates River's basin in Saudi Arabia is limited by many large valleys, which drain the extreme northern parts of Saudi Arabia into the river (Fig. 1). The south western valleys of the basin, which form the tributaries of Wadi Hauran run in carbonates rocks of Cretaceous age. Whereas, those valleys in the central southern and south eastern parts of the basin run in carbonate rocks of Paleocene – Eocene age (Alsharhan and Narin, 1997).

The Euphrates River as it enters to the Iraqi territory from Syria runs in the Euphrates Formation (Fig. 7). The formation consists of limestone, dolostone and marl. The age of the rocks is Lower Miocene (23.03 Ma). It continues flowing within this formation until the old Anah town, there it flows in the rocks of the Anah Formation, which consists of very hard limestone; locally includes corals.

Near Alus town, between Haditha and Hit towns on the left side of the river, the rocks of the Fatha Formation are exposed. The formation consists of cyclic deposits of green marl, reddish brown claystone, limestone and gypsum; the age is Middle Miocene (15.97 Ma). Near Hit town, west of Ramadi about 70 km, the river flows entirely within the rocks of the Fatha Formation.

Between Hit town and Al-Ramadi city, on the right side of the river, the rocks of the Nfayil Formation are exposed. The formation consists of an alternation of green marl and limestone; the age of the formation is Middle Miocene (15.97 Ma).

Northwest of Al-Ramadi city by about 15 km, the Euphrates River runs in the Mesopotamian Plain and continues until it merges with the Tigris River near Al-Qurnah town. The sediments of the Mesopotamian Plain consist mainly of silt and clay; however, locally some depressions occur. They may have some organic soil with silt and clay. It is worth mentioning that after Al-Nasiriyah city, the Euphrates River starts flowing in a marshy area (Fig. 7). The sediments there are highly contaminated with organic materials. The age of all those sediments is Holocene (11.7 Ka).

Concerning the remaining parts of the Euphrates River's basin, the exposed rocks range in age from Paleozoic of the Gaara Formation up to Pliocene –

Pleistocene rocks of the Zahra and Dibdibba formations. The exposed formations are: Gaara (Paleozoic), Mulussa and Zor Hauran (Triassic), Ubaid, Hussainuat, Amij, Muhaiwr, and Najmah (Jurassic), Nahr Umr, Mauddud, Rutbah, Msad, Tayarat, Harha, Digma and Marbat Beds (Cretaceous), Umm Er Radhuma and Akasaht (Paleocene), Jill, Dammam and Ratga (Eocene), Sheikh Alas, Shurau, Baba, Azkand and Anah (Oligocene), Ghar, Euphrates, Fatha, Nfayil and Injana (Miocene), and Zahra and Dibidibba (Pliocene – Pleistocene). The main dominant rocks are carbonates followed by claystone, sandstone and very rare gypsum.

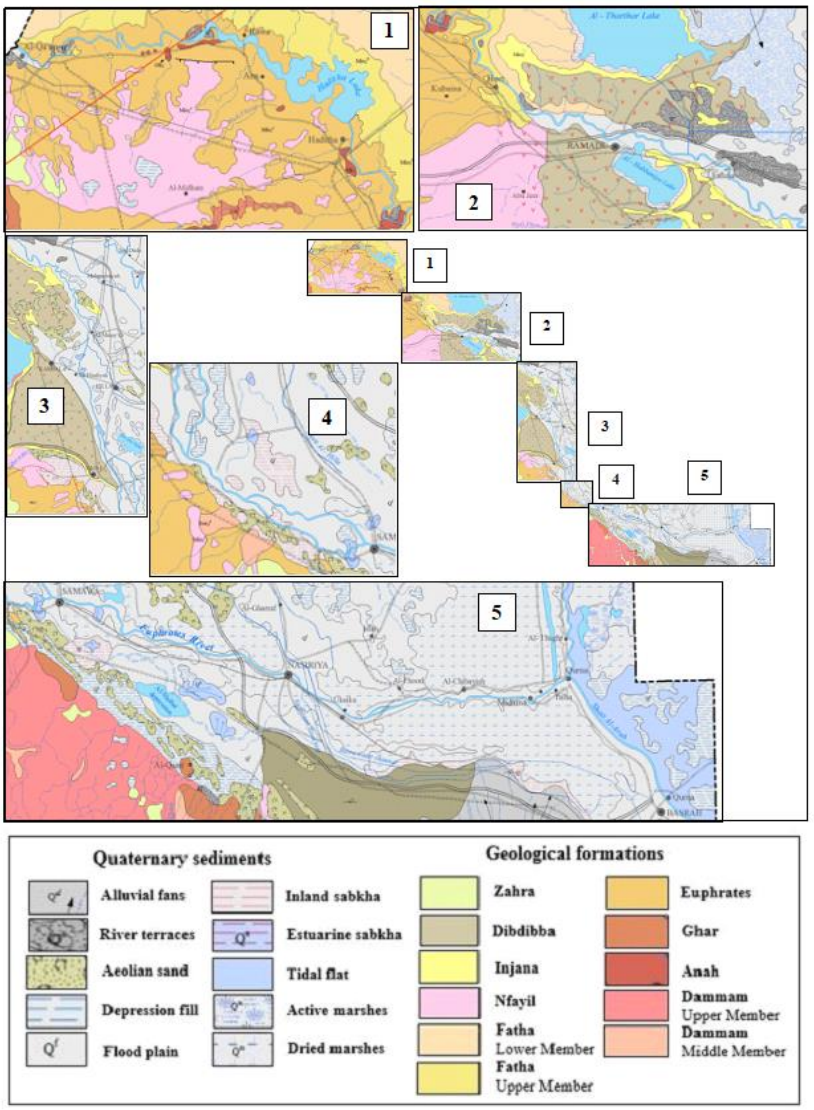


Figure 7: Geological map of the Euphrates River's course. The small portions show the geographic relation between the five parts of the geological map (After Sissakian and Fouad 2012).

# 4 Mineral Resources

The mineral resources within the basin of the Euphrates River in Iraq including both Western and Southern Deserts (Fig. 8), which are drained towards the river by tens of valleys are mentioned hereinafter. The presented data are acquired mainly from (Al-Bassam, 2007 A).

**1. Phosphate**

Phosphate occurs within the Akashat Formation, which is exposed along wadi (valley) Akash (Fig. 8). The mines of the phosphate are located along the banks of wadi Akash along the Iraqi –Syrian borders. The phosphate is transported by trains from the mines to Al-Qaim Complex south of Al-Qaim town (Al-Bassam, 2007 A and B).

**2. Limestone**

The main uses of the limestone are:

a) Cement Production: Limestone for cement production is found in the Dammam, Ratga and Euphrates formations in enormous amounts. The formations are exposed along many valleys in the Western Desert. Eight cement plants are located within the basin of the Euphrates River (Fig. 9). The first one is Al-Qaim cement plant; it uses limestone from the Ratga Formation; however, the quarry is very far from the cement plant. The other plants are located either along the course of the river or slightly west of to the river. The plants are Kubaisah, Al-Fallujah, Al-Hindiyah and Al-Kufa, Karbala, Najaf and Simawa. They all use the limestone quarried from the exposures of the Dammam, Ratga and Euphrates formations.

b) Rock Slabbing Plant: One rock slabbing plant is located between Haditha and Haqlaniyah towns. The used limestone is quarried from the exposures of the Euphrates Formation. The plant; however, was abandoned due to difficulties in the limestone quarry. Therefore, it is used nowadays as rock slabbing plant for igneous and metamorphic rocks transported from the northern parts of Iraq.

Moreover, limestone of the Ratga Formation is used as rock ballast for rail way constructions (Abdul Ahad, 2006).

**3. Uranium**

Uranium is present in the rocks of the Euphrates Formation in Abu Skhair vicinity, south of Al-Najaf City (Fig. 8) (Mahdi and Al-Attaiya, 2005 and Al-Bassam et al., 2006). It is also present in the phosphate deposits, which are exposed in Akashat Formation in Akashat vicinity, NE of Rutba (Al-Bassam, 2007 C).

**4. Oil and Gas**

Many oil fields with different daily production and different oil types and reserves are located along the course of the Euphrates River (Fig. 9). All the oil fields are subsurface fields, such as Fallujah, Al-Kifil, Subba, Qurna West and Rumaila North oil fields. However, the majority of the Southern and Western Deserts are believed to include oil fields of stratigraphic type. But, they are not discovered yet. Natural gas was discovered in Akass filed south of Al-Qaim along wadi Al-Mana'i and wadi

Al-Ratga (Fig. 9). Many wells were drilled during late nineties of the last century; however, it is not yet fully discovered.

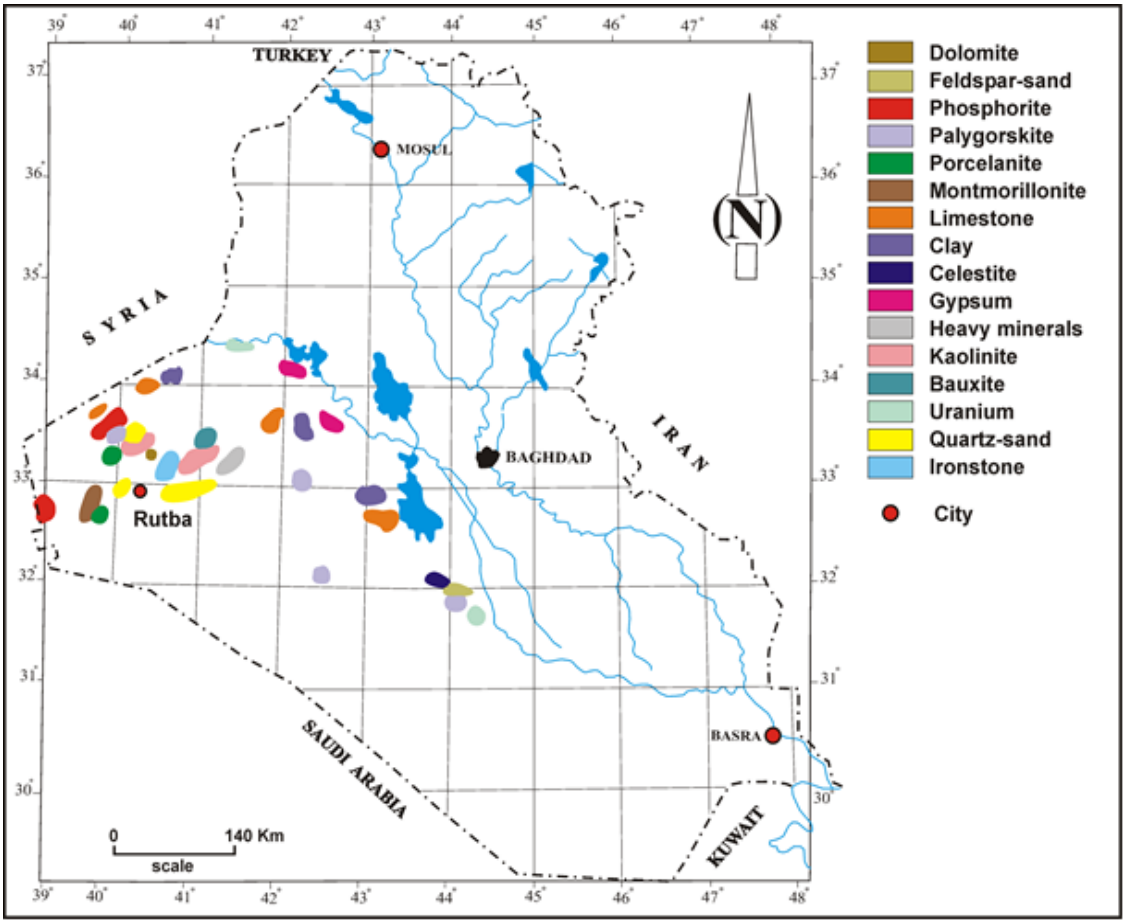


Fig. 8. Distribution of Mineral resources in the Western Desert of Iraq (After Al-Bassam, 2007 a).

**5. Clay**

Clay occurs in enormous amounts in the flood plain of the Euphrates River and the Mesopotamian Plain. The main use is in brick production, many brick plants are located along the course of the Euphrates River; such as in Al-Hilla city, Al-Mahaweel town. Another use of clays is in cement plants. The used clays are from the large shallow depressions which occur in the western and southern deserts.

**6. Glass-sand**

Glass-sand occurs in enormous amounts with the Rutba Formation. A main quarry for glass-sand exists at Urdhuma; 12 Km west of Rutba city (Sissakian and Al-Jiburi, 2007). It is pure quartz sand; reaching 98% purity. (Al-Bassam, 2007 A).

The main use of the sand is in glass industry at Ramadi city.

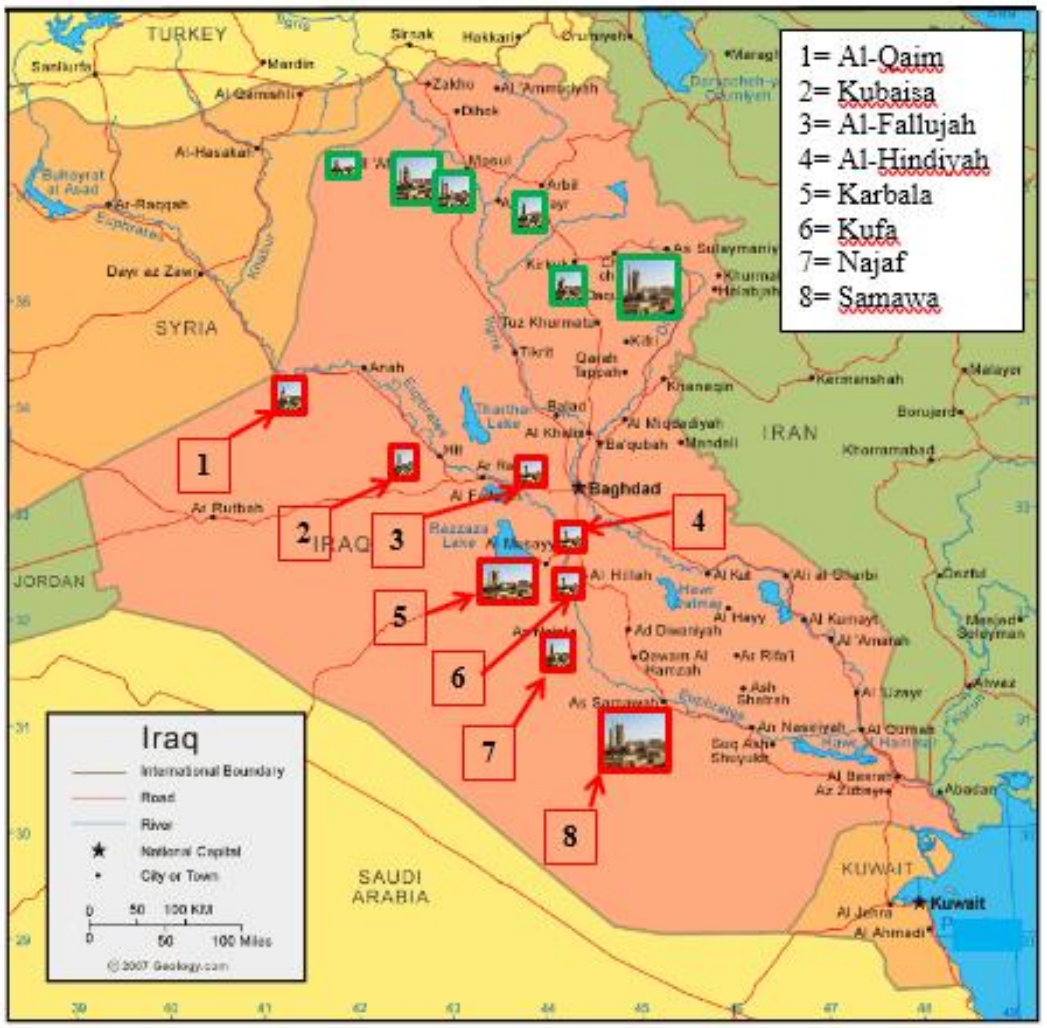


Figure 9: Cement plants in Iraq. In red are those within the basin of the Euphrates River, in red are those within the basin of the Tigris River

**7. Sedimentary Iron**

Sedimentary iron of different percentages occurs in Hussainiyat Formation; at Hussainiyat vicinity along wadi Al-Hussainiyat (Fig. 8) (Al-Bassam, 2007 A). The valley is one of the main branches of wadi Hauran. The sedimentary iron is quarried and used in cement plants of the southern Iraq.

**8. Kaolinite**

Kaolinitic claystones are restricted in occurrence to the Western Desert (Fig. 8) and in age to the pre Cretaceous units. The upper parts of the Ga`ara Formation (Permocarboniferous) in the Gaara Depression, which is drained to the Euphrates River through wadi Al-Mana'i are characterized by kaolinitic claystone deposits

of various types including white and colored varieties. They are also known to be in the lower parts of the Hussainiyat Formation (Early Jurassic) along Wadi Hussainiyat and in the Amij Formation (Middle Jurassic) at Wadi Amij (Mahdi et al., 1990 and Mahdi and Al-Delaimi, 1999 in Al-Bassam, 2007 A).

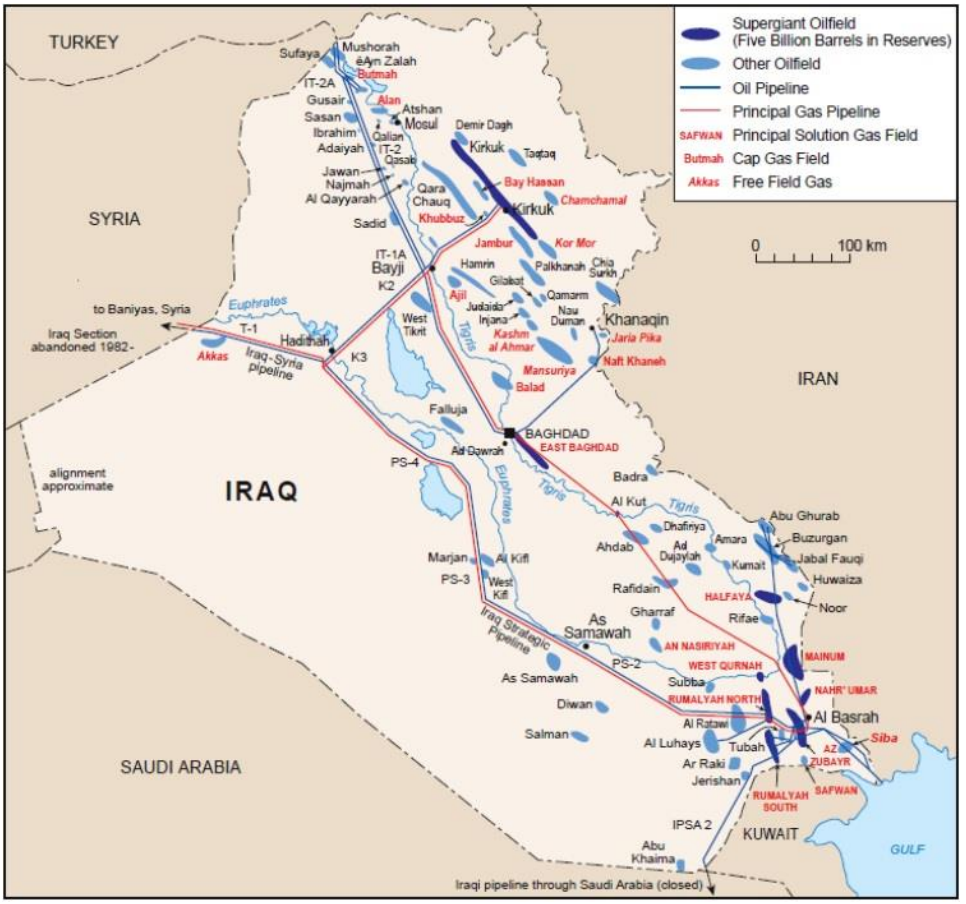


Figure 10: Distribution of oil fields within the basins of the Tigris and Euphrates rivers

## 9. Montmorillonite and Palygorskite Claystones

Montmorillonite and palygorskite of Late Cretaceous age are present in the Western Desert within the Digma Formation, which is exposed along the western rim of the Gaara Depression and southwards along the banks of wadi Hauran (Fig. 8) (Sissakian and Al-Jiburi, 2007). These claystones are originally black shales, rich in the carbonaceous matter. They were oxidized to yellow and green claystones in surface and near-surface sections (Al-Bassam, 2007 A).

**10. Karst Bauxite**

Bauxite and bauxitic kaolinites were discovered filling up to 70 m deep karsts in the carbonates of the Ubaid Formation (Early Jurassic) (Al-Bassam, 2007 A) at Al-Hussainiyat vicinity along the course of wadi Al-Hussainiyat, which is a main branch of wadi Hauran (Fig. 8) (Sissakian and Fouad, 2012). The bauxite was quarried at Al-Hussainiyat vicinity until 2003 and was used mainly in drilled boreholes for geotechnical purposes.

**11. Gold**

Since early decades of the last century, the occurrence of gold in the Western Desert was a matter of debate. The following paragraph briefs the attempts of finding gold in the Western Desert "Iraqi geologists have been working to figure out locations and quantities of gold deposits. Some have found occurrences of gold in the Gaara formation consisting of ferruginous sandstones and ironstones of the Gaara depression in the western desert of Iraq. Studies reveal that in 1934, Mc Fayden was the first to convey the possibility of finding gold in the Gaara sandstones. However, his investigations could not prove the presence of gold deposits. This was long forgotten until in 1984 when two geologists, Kettanah and Tobia accidently discovered the occurrence of gold while looking for presence of iron. In 1986, Al-Bassam collected a number of samples from Chabid Al-Abid region in Gaara Depression and concluded that the proportion of gold found in the samples was not commercially viable. Later in 1999, another study by Mustafa in the same area showed that the samples from region did contain adequate concentration of gold. The above research is documented by Mazin M. Mustafa and Faraj H. Tobia" (Internet Data, 2015).

**12. Zirconium and Titanium**

Zirconium and Titanium with some other heavy minerals were found in the valley fill sediments of some large valleys in the Western Desert and within the Amij Formation (Middle Jurassic). The Amij Formation is exposed northeast of Rutba town (Sissakian and Fouad, 2012). Mahdi and Al-Mukhtar (2006) reported about the presence of considerable amount of zirconium and titanium in the Amij Formation.

**13. Gravel and Sand**

Gravel and sand are deposited in enormous quantities along the courses of the main valleys of the Euphrates River. The gravel and sand are mainly present as valley-fill sediments, in form of pebbles (for the gravels) of different sizes, forms, shapes and lithology. They are quarried, sieved and washed in large quantities and used for different constructional purposes.

# 5 Conclusions

From the current study, we conclude the following:

The Euphrates River flows in Turkey, Syria and Iraq in different Tectonic zones, different types of rocks and soils, and different landscapes. The majority of rocks within the river's basin are carbonates, marl, claystone and sandstone with rare gypsum and conglomerate. In Turkey, the river flows in Anatolide – Turoside Block, and crosses the Northern and Eastern Anatolian faults and in the Bitlis – Zagros Suture Zone. Inside Syria it flows in the Arabian Plate; represented by the Aleppo Plateau. It is also affected by Irbid Rift and the Palmyrides. The river before entering Iraq, flows in the Azraq Graben, which is the continuation of the Ana Graben in Iraq. In Iraq, it forms the contact between the Inner Platform and the Outer Platform until near Hadith, then flows within Al-Jazira Zone, then parallel to Abu Jir –Euphrates Fault and finally with the Mesopotamian Plate.

The basin of the Euphrates River is rich in different non- metallic minerals with enormous quantities. Limestone, dolostone and glass sand are also present in huge quantities. Moreover, the basin includes many oil and gas fields.

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