

Geological And Geophysical study for Fatima Shrine in Al- Najaf Governorate by using(G.P.R)Technology

Abdulzahraa M.Alabbassi

Kufa University
College of Sciences
abdulzahraa_2000@yahoo.com

Ayeid J.Alzameley

Kufa University
College of Arts

Hussien M. Ali

Kufa University- College of
Education for Females.

Abstract:

The survey by the **G.P.R.** in the site of Fatimah shrine and around it in the city of Najaf was represented an indications of cavities within the penetrated depth up to about 18m as shown in the profiles No.(232cavity, 234cavity, 235cavity). Inside the site the profiles are not indicate any cavities within the layers.

The G.P.R profiles indicate the following layers :

1- (5m) reworked material.

2- (12m) sandstone with velocity of (6.5cm/ns) and ($\epsilon= 21.4$).

This layer consist of sandstone of Dibdibba formation which consist of cross bedded sandstone with very hard thin beds of Celestite in the upper most part and very hard massive sandstone in the lower part. In the lower most part of this layer (1.5-2m) loosed friable pebbly sandstone was found. From the above mentioned description the area of Fatima shrine was found on the Dibdibba sandstone formation.

3- (6m) clay stone with (8.4 cm/ns) and ($\epsilon= 12.7$).

4- (25m) cyclic deposits of clastic sediments.

Consist of sandstone cross bedded and siltstone and clay stone. Within this bed the water table could be recognize. The boundaries below the water table are not highly clears for recognition, then we used many different type of filter and processing methods to recognize these boundaries .The water table in the city of Al-Najaf is between (20-25m) below the surface of the earth.

Keywords: Ground penetrating Radar G.P.R. ,Site of Fatima shrine, Automatic gain control AGC. , Radar gram profile ,dielectrical constant , wave velocity in ns., celestite Srso4.

دراسة جيولوجية و جيوفيزيائية لصحن فاطمة في مدينة النجف الاشرف باستخدام تقنية الرادار
الارضى(G.P.R)

أ.م.د حسين محي علي

جامعة الكوفة / كلية التربية للبنات

أ.م.د عايد جاسم الزامل

جامعة الكوفة / كلية الاداب

م.د عبد الزهرة موسى عبيد

جامعة الكوفة / كلية العلوم

الخلاصة:

ان المسح باستخدام تقنية الرادار الارضي (G.P.R) في صحن فاطمة وحوله في مدينة النجف الاشرف بينت لنا وجود كهفات في الاعماق المخترقه ولحد ١٨ متر نحو الاسفل من سطح الارض ومثلما نشاهدها في المقاطع ٢٣٢ ، ٢٣٤ ، ٢٣٥ . المقاطع التي اخذت في داخل الموقع للصحن لم توشر وجود فجوات في الطبقات التي اخترقت بالرادار. ان مقاطع الرادار الارضي في صحن فاطمه بينت لنا الطبقات التالية من الاعلى نحو الاسفل :

١- ٥ امتار مواد ركام للبناء القديم .

٢- ١٢ متر حجر رملي سرعة الموجه فيه ٦,٥ سم/نانوسكند وتوصيلة الوسط ٢١,٤

من هذا الصف يتبين ان صحن فاطمه يقع ضمن تكوين الدبده الذي يتكون من طبقات الحجر الرملي ذو التراكيب المتقاطع مع وجود طبقه صلبه جدا من معدن السلسايت في الجزء العلوي وكذلك حجر رملي سميك وصلب في الجزء الاسفل والذي ينتهي بطبقه ذات سمك يتراوح من ١,٥ - ٢ متر من الرمل الناعم عديم التماسك .

٣- ٦ متر حجر طيني ذو سرعه ٨,٤ سم/نانوسكند وتوصيلية الوسط ١٢,٧

٤- ٢٥ متر من الترسبات القاريه المتكرره تتكون من حجر رملي ذو تطبيق متقاطع وحجر غضاري وطيني . في هذه الطبقة يمكن مشاهدة مستوى الماء الجوفي . ان الحدود بين الطبقات تحت مستوى الماء الجوفي تكون غير واضحه ولهذا استعملت عدة انواع من الفلاتر وطرق المعالجه للمعلومات المسجله في الموقع بجهاز الرادار الارضي وذلك لغرض تمييز الحدود الطبقيه . ان مستوى الماء الجوفي في مدينة النجف يتراوح بين ٢٠-٢٥ متر تحت مستوى سطح الارض.

الكلمات المفتاحية: رادار الاختراق الارضي G.P.R ، السيطره الآليه في المقدار ، المقطع الراداري، ثابت العزل الكهربائي، سرعة الموجه بجزء من البليون من الثانيه، السلسايت SrsO4.

1. Introduction

Al-Najaf extend between (440 15 23 – 440 25 25) longitude and (310 54 25 - 320 02 45) latitude (fig.1 A,B).

The city of Al-Najaf was found on the western edge of the middle Mesopotamian plain, and about 10km. SW of Euphrates river. The reliefs in the city and around it range between (15 - 64 m).

Above sea level. The center of the depression to the west of the old city (Bahr Al-Najaf) reach about (5-8 m) above sea level.

Tar Al-Najaf represent a sharp edge which could be seen from long distance from the west. It prevents the flooding of

the cities which found on the East of Al-Tar during the heavy rains.

Clastic sediments consist the exposed sedimentary cover in the area of Al-Najaf to a depth of about (50 m).

These clastics consist essentially of sandstone, siltstone and claystone.

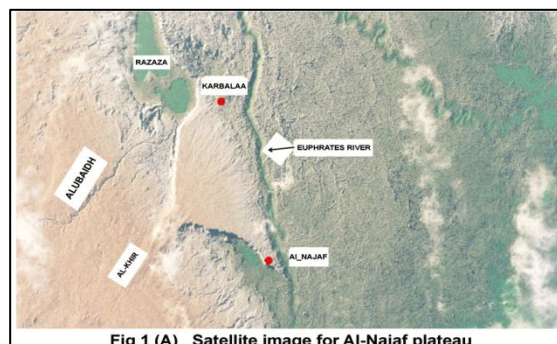
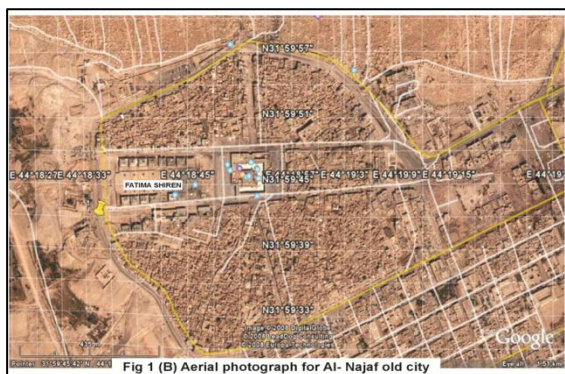


Fig 1 (A) Satellite image for Al-Najaf plateau



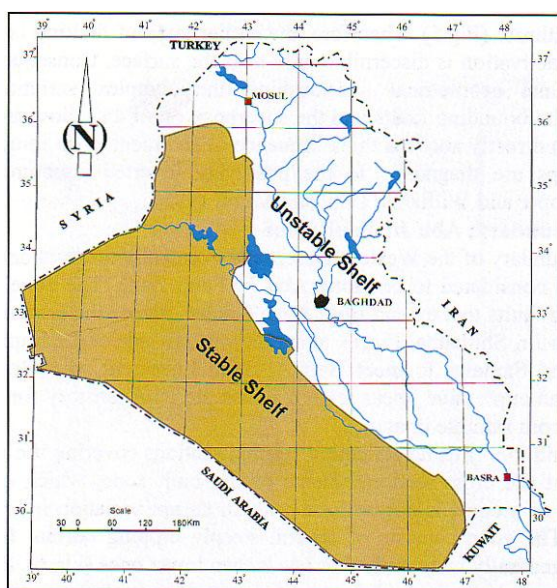
2. Aim of study

The study was done in the Fatima shrine site and around the old city of Al-Najaf in order to understand the stratigraphy sequence of the deposits and its physical, chemical and thickness characteristics.

This study enables us to prepare a geological map and Hydro- geological map and many cross sections by the ground penetration Radar(G.P.R).

3. Geology of Al-Najaf area:

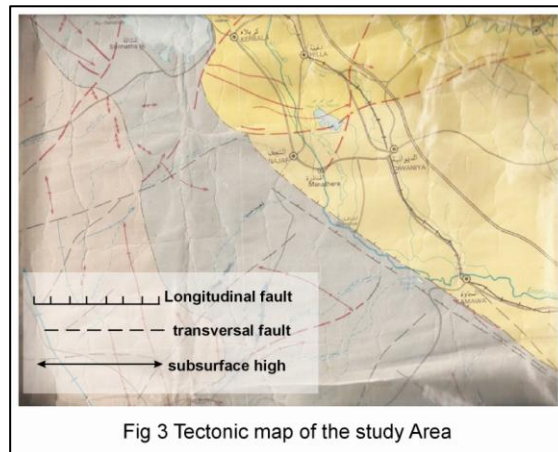
A) Tectonic: According to the tectonic subdivision of Iraq the area of Al-Najaf was found on the border zone between the stable and the unstable shelf (fig. 2).6,7.



(Fig. 2): The boundary between stable and unstable shelf

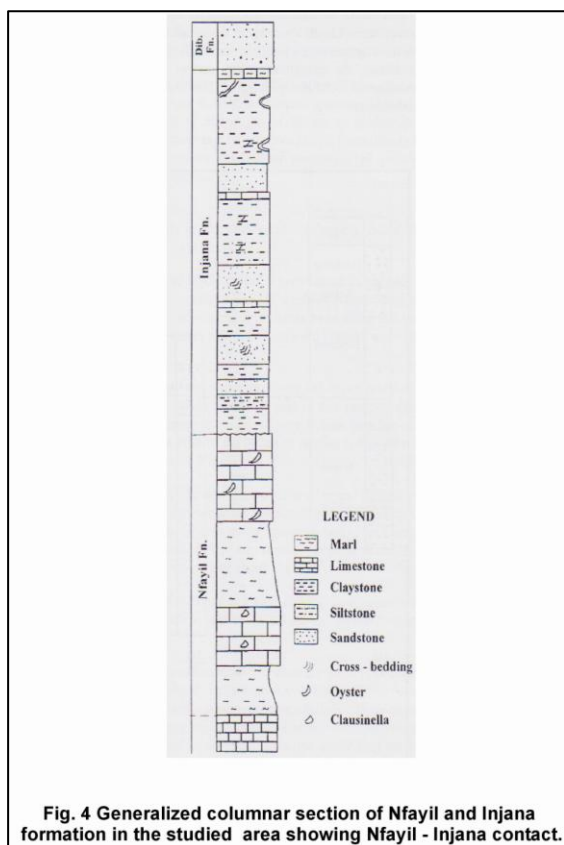
The fracture zone of Abujir – Al Furat which elongated North West – South East cuts to the

west of Al- Najaf town i.e within the area of Bahr Al- Najaf (fig. 3)



There are some indications from time to time along this zone of these fractures like fire due to the combustions of hydrocarbon gases which come from deep-seated zone ascended upward and become in contact with the surface air and burn up, also there is accumulation of Tar in some areas that are cut by these fractures. There are many springs concentrated along the fault zone.

B) Description of stratigraphy of the area: The stratigraphy of Al-Najaf area can be described from older to younger ages as follow (fig. 4). 2,3,4.



1-Euphrates formation (Early Miocene):

It is the oldest exposed formation in the area. Only the uppermost part of the formation is exposed. It consists of limestone gray to yellowish gray or pale gray, medium tough to tough, medium bedded, almost fossiliferous, generally step or cliff forming. The contact with the overlying Nfayil formation is clear and conformable, taken at the top of the medium bedded limestone and the first appearance of green Marl of Nfayil formation with thickness more than (2 m).

2-Nafayil formation (middle Miocene):

This formation formally represent lower Fars formation, but without gypsum, the Nfayil is exposed at the base of scarps. It is composed of alternation of marl and limestone in cyclic deposition. Two main cycles can be recognized in the area, each cycle consists of marl, yellow to yellowish green, friable, medium tough, slope forming, overlain by limestone, gray tough, cliff forming. Oyster shells are

dominant in second cycle. The contact with the overlying Injana formation is marked by the first appearance of brown to reddish brown clastic sediments (claystone or sandstone) of Injana formation. The thickness of this formation is (2-15 m).

3-Injana formation (upper Miocene):

The formation is cropping along Tar Al-Najaf and Tar Al-Sayyed. The formation is divided in two units in the area:-

- A) Lower clastic unit: This unit consists of alternation of different clastic rocks (claystone, sandstone and siltstone) or admixture of these rocks in different ratios. Thin beds of marl limestone are also recorded, two or three times, reach up to (0.3 m) in thickness. Some Celestine – bearing beds are recorded in places. Cementing materials are clay or carbonate, solution of diagenetic processes occasionally fills the bedding plane and fractures forming of very thin or local aggregates of secondary gypsum. The color of all components is brown to reddish brown medium tough to tough and cliff forming. The sandstones are heterogeneous, micaceous lithic, cross bedded of gray color. The cycles show fining upwards, the thickness of the succession of this unit shows some lateral and vertical versions.
- B) Upper cave – forming unit: The thickness of this unit is about (6 m) or more in some places. This unit has a wide geographic extent in both Tars up to (170 km). And highly jointed and fractured and one can remark two sets of joints East – West and North – south. It overlies by

highly permeable coarse grained sandstone of Dibdibba formation.

4-Dibdibba formation(Upper Pliocene-Pleistocene):

The thickness of this formation ranges from Less than (1 m) up to more than (18 m). It consists of sandstone and pebbly sandstone. The major components of the sandstone beds in this formation are quartz, chart, rock fragments and feldspar. The ratio of these components differs from place to another. The cementing materials are clayey, in the friable sandstone and calcareous or gypsiferous in the medium tough sandstone. Some claystone and siltstone beds are recorded, particularly in the eastern and South eastern parts of the area.

5- Quaternary:

The quaternary of Al- Najaf city can be described from west to east (i.e from Bahr Al-Najaf in West to Kufa in East).

The middle part of Bahr Al-Najaf is composed of quaternary sediment which is reaching in thickness up to (38m) in the center of the depression.

The quaternary sediment in this area composed of sandy and silty clay usually used in brick factory

These quaternary deposits represent the flood plain deposits of Euphrates river. The center of Bahr Al-Najaf is represented by (sabkha) deposits especially to the west of Al-Najaf city. The quaternary sediment over lain un- conformably the formations of Euphrates limestone of L .Miocene age ,Nfayil and Injana deposits of M.U Miocene age(fig. 5)

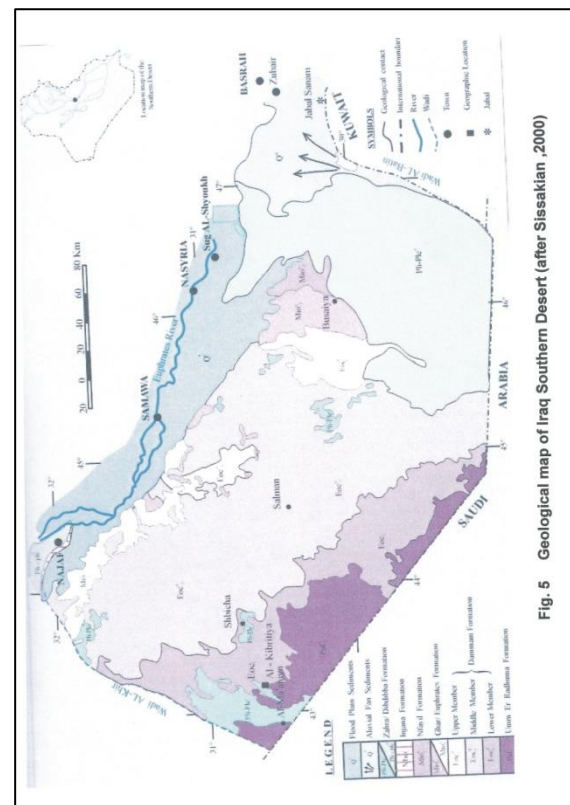


Fig. 5 Geological map of Iraq Southern Desert (after Sissakian, 2000)

C) Description of lithology of Fatima shrine depending on Radar profiles (G.P.R): 5,9

The area of Fatima shrine was covered by many G.P.R profiles. The profiles are of N-S and E-W directions. The Radar which is used in survey is of three types (500 MHz, 250 MHz, 100 MHz) in order to reach a depth of more than 60 m. Software used see the appendix:

- 1- Rad Explorer.
- 2- Easy 3D.

The filters used in this work are :

- 1- Time zero adjustment.
- 2- DC Removal.
- 3- Background removal.
- 4- Amplitude correction.
 - a) automatical gain control(AGC).
 - b) Spherical divergence correction.
 - c) Trace equalization.
- 5- Band pass flitter.
- 6- Stolt F-K migration.

The sketch (6) illustrated below represents the topographic map of the site of sahan Fatima indicated on it the paths of radargram profiles which are numbered .These profiles are made inside and beside the excavated area of Sahan Fatima. The images of GPR profiles are shown in the appendix and with each profile we are indicated the type of antenna that was used in the test, the penetration depth (m), the length of the profile (m), sampling frequency (MHz) and time window (ns).

Profiles (231, 232, 235) are made in the streets outside the excavated area of shrine Fatima.

Seven horizons can be recognized in the above mentioned profiles from 1 through 7 while the profiles (243, 245,246, 247, 255 and 256) were taken inside the excavation .There are only five layers (3 through 7) can be recognized because of the upper two horizons and part of the third horizon are removed due to digging. **See the figures of GPR profiles at the appendix.**

The obtained profiles show many layers which can be described as follows:

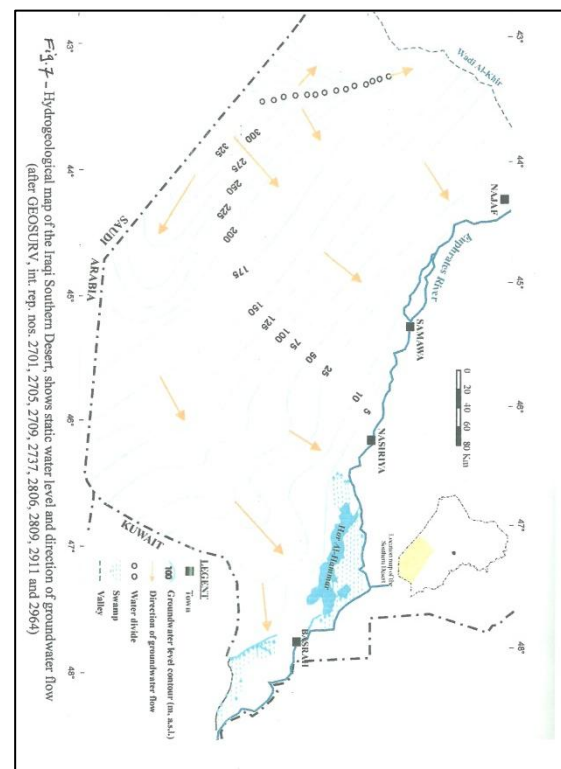
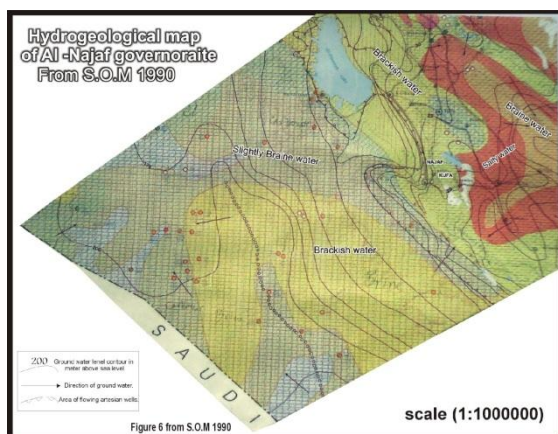
Artificial materials	↕	1- Pave road and reworked materials (6m thick).
Dibdibba formation	↕	2- Cross bedded sandstone with Celestite (4m thick). 3- Massive hard sandstone (4m thick). 4- Sandstone friable(1.5m thick).
Injana = upper Fars formation	↕	5-Red claystone cave forming, represents the upper unit of upper Fars formation (6m thick). 6-Lower clastic unit (25m thick) consists of alternation of different clastic rocks (claystone, sandstone and siltstone).

Nfayil = lower Fars formation	↑ ↓	7- Alternation of marl and limestone, the lower cycle consists of yellow to yellowish green marl, the upper cycle consists of yellows green marl overlain by oyster bearing limestone (total thickness is 10m).
Euphrates limestone Lower Miocene age	↑ ↓	8- Limestone hard, bedded, gray color fossiliferous exposed thickness is more than 2m.

D) Hydrogeology:

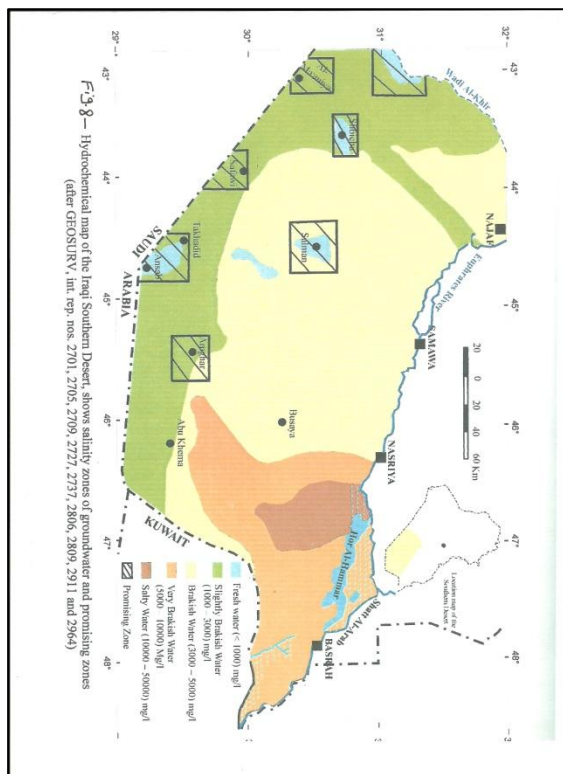
The Hydrogeological map of Al-Najaf city which is prepared and From the surface of the earth. This water table becomes more deeper towards the NW of the city, and the general direction of the area of flowing of artesian wells is towards the NE.

The water table is approximately from 20-25m published by S.O.M.1990 shows that the (fig.6).



The underground water type of Al-Najaf city is brackish water with salinity between (3000-5000 mg/L) (fig.8).

The water table becomes more deep towards the west and reach about 325m below the surface of the earth towards the border between Iraq and Saudi Arabia (fig.7).

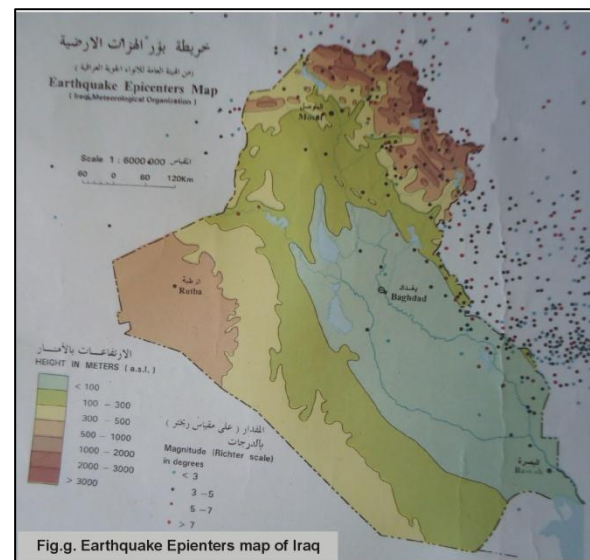


Two shallow aquifers of under ground water was found in the sediments of the area: one in the quaternary and the other in Dibdibba formation these aquifers represent the most important aquifers in the area.

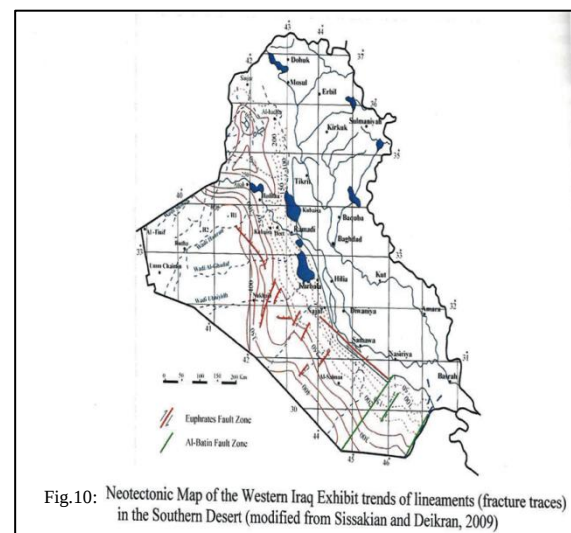
The under ground water aquifers of Euphrates formation is of less important due to its local extension and its high water salinity.

E) Seismicity:

The area of Al-Najaf was situated within the western edge of the mobile belt which has a seismicity increased from SW towards the NE. The magnitude of Seismicity in Richter scale in the studied area is fluctuated from less than 30 up to 30-50 (fig. 9)



Some epicenters were registered to the SE of Razaza lake during 1992. The neo- tectonic map of the Mesopotamia plain (1998) (fig.10) Show that the active Euphrates fault was found to the SW of Al-Najaf town. The Plain of the fault is not clear on the surface of the earth, but there is line of spring elongated NW-SE and also an increase of heat was recorded along the fault zone recently.



4. Conclusion

From our survey by the G.P.R. in the site of sahan Fatimah and around it there are indications of cavities within the penetrated depth up to about 18m as shown in the profiles No.(232cavity, 234cavity, 235cavity) which could be seen in the

appendix. Inside the site no indication of any cavities are represent within the layers.

The G.P.R profiles are indicated the following:

1- (5m) reworked material.

2- (12m) sandstone with velocity of (6.5cm/ns) and ($\epsilon= 21.4$).

This layer consists of:

From the above mentioned description the area of Sahan Fatima was found on the Dibdibba sandstone formation. The description of sediment from the surface of the earth downward was as follows:-

1- (5 m). Reworked soil.

2- (12 m). sandstone of Dibdibba formation which consists of cross bedded sandstone with very hard thin beds of Celestite in the upper most part and very hard massive sandstone in the lower part. In the lower most part of this layer (1.5-2m) loosed friable pebbly sandstone was found.

3- (6m) claystone with (8.4 cm/ns) and ($\epsilon= 12.7$).

4- (25m) cyclic deposits of clastic sediments.

Consist of sandstone cross bedded and siltstone and clay stone. Within this bed the water table could be recognized.

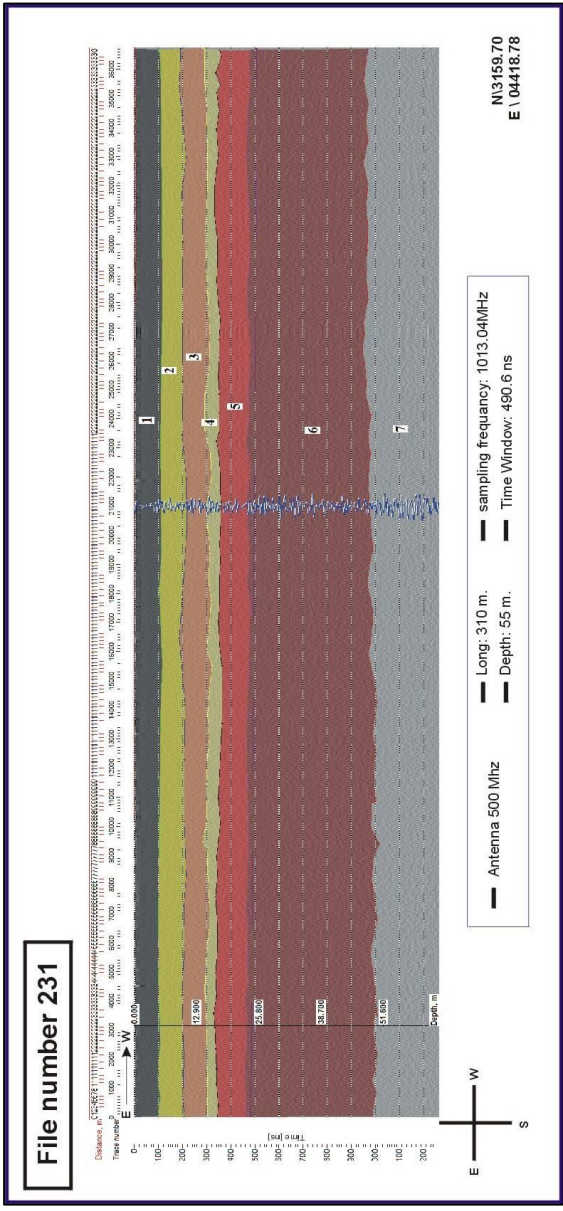
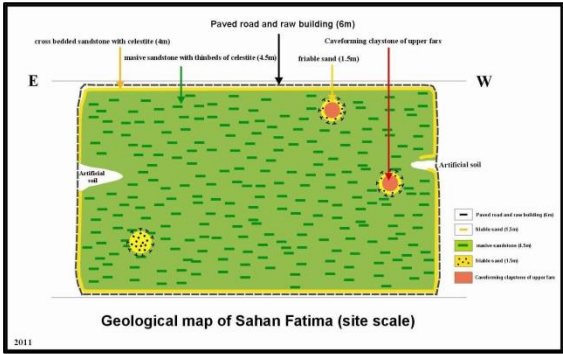
The boundaries below the water table are not highly clears for recognition, then we used many different types of filters and processing methods to recognize these boundaries.

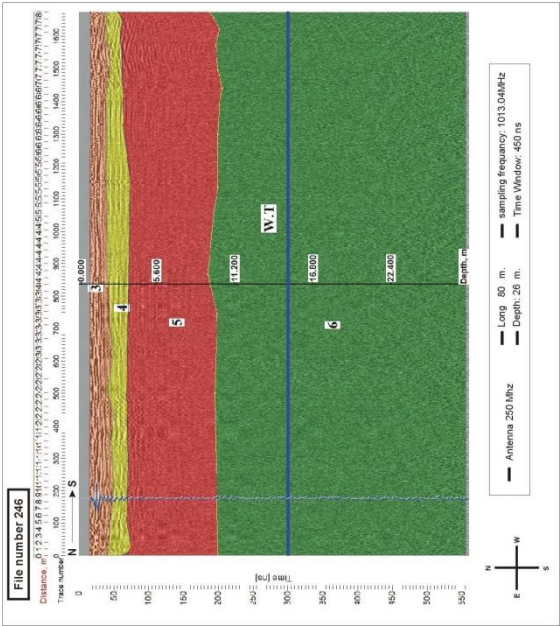
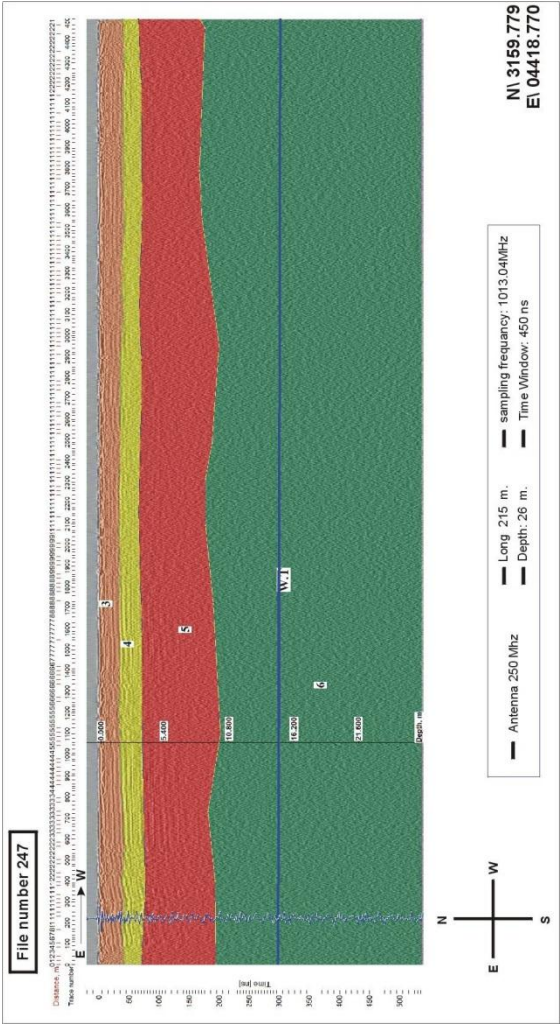
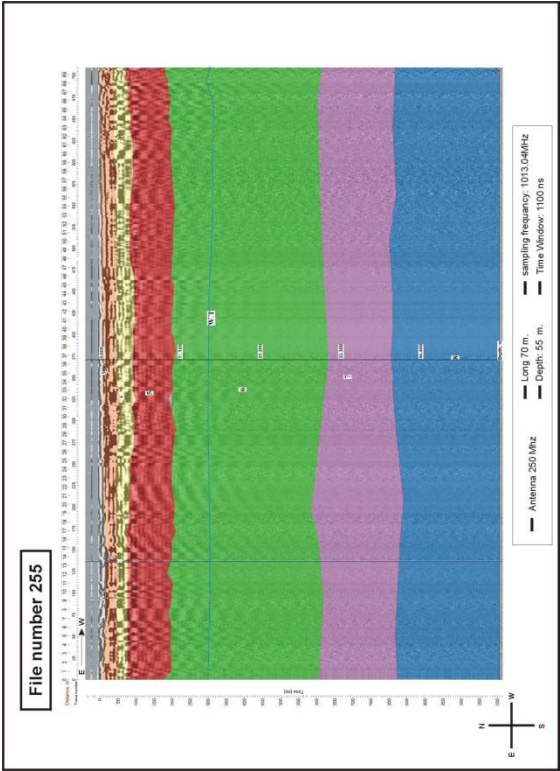
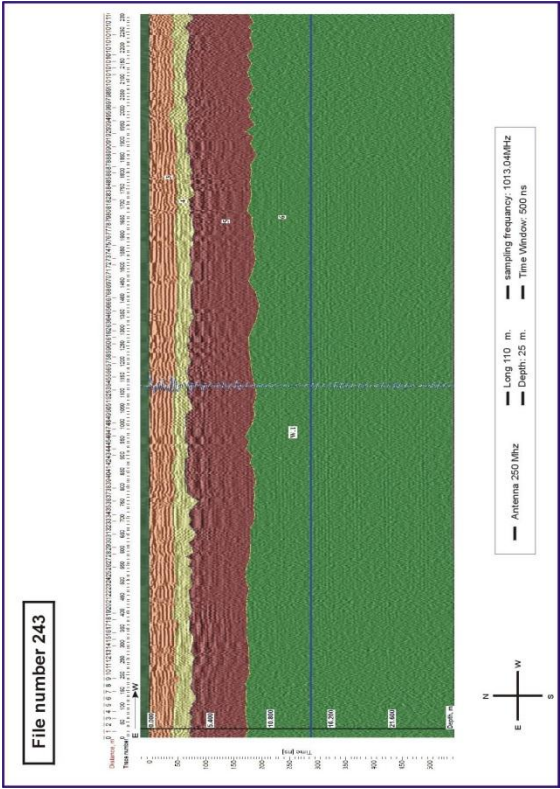
The water table in the city of Al-Najaf is between (20-25m) below the surface of the ground.

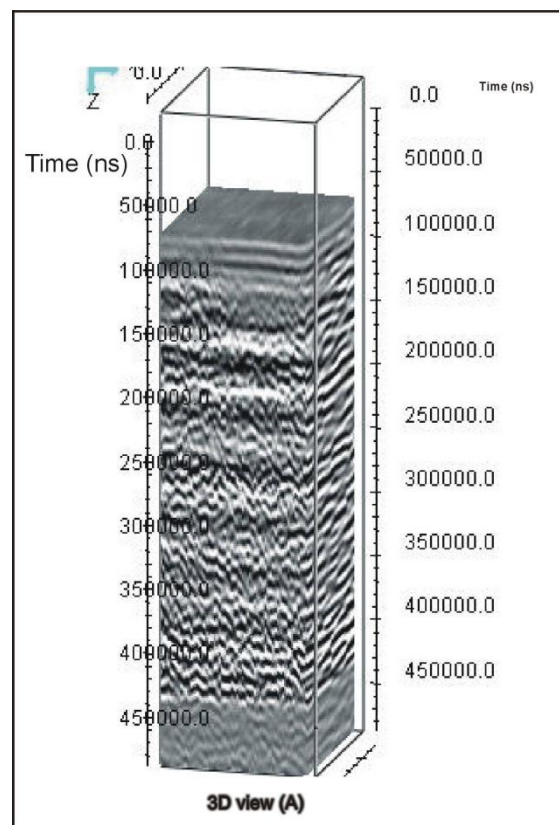
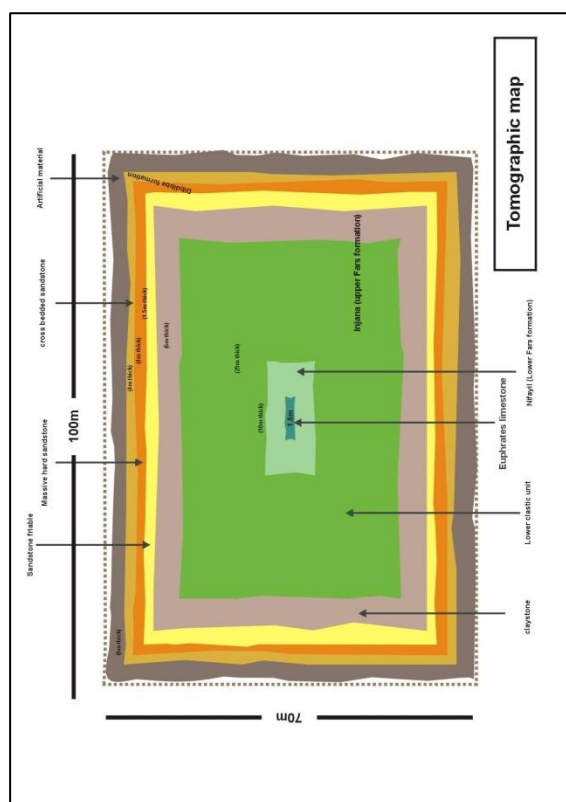
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Appendix for the G.P.R and geology traverses







Picture in The site of Sahan Fatima.