Geotechnocal Mapping of An-Najaf City, Iraq

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Abstract

The present paper submits a set geotechnical maps for the area of An-Najaf city, by using countor lines to represent the different geotechnical properties of the soil. The present research work is very important step taword preparing a geotechnical database for this region, to complete the geotechnical database over all the country, (Iraq). Using such a database is very important in geotechincal investigation, reconnaissance phase, of construction projects. Whithin this phase of site investigation, numbers, depths and locations of the boreholes needed, will be deterimined. A well known commercial software (SURFER 11), was used to produce the all the countor maps of geotechnical properties presented herein. A forty nine (49) countor maps were produced to cover the variations, whithin the geotechnical properties of the soil, to produce realistic description to these soil properties. Both Google maps and Universal Transverse Mercator coordinate system (UTM) have been used in the countor maps for easy use.

Keywords:Geotechnical maps, An-Najaf city, Engineering properties of soil, Countor lines.

الخلاصة

تقدم الدراسة الحالية مجموعة من الخرائط الجيوتكنيكية لمنطقة مدينة النجف ألأشرف. تم أستخدام الخرائط الكنتورية لتمثيل الخواص الجيوتكنيكية المختلفة لتربة المنطقة قيد الدراسة. تتمثل أهمية البحث الحالي في كونه أسهام في لعمل قاعدة بيانات للخواص الجيوتكنيكية لتربة المنطقة، ومن ثم أكمال قاعدة البيانات لعموم جمهورية العراق. أن أستخدام قاعدة البيانات لخواص التربة الجيوتكنيكية هو امر مهم جدا في تحريات التربة للمشاريع الانشائية، وبالخصوص في طور جمع المعلومات، وكذلك يمكن استخدامها لغرض تحديد عدد واعماق ومواقع الأبار ألأختبارية. تم أستخدام البرنامج التجاري (SURFER 11) لغرض رسم الخرائط الكنتورية للخواص الجيوتكنيكية لمنطقة الدراسة، حيث تم رسم وانتاج (٤٩) خارطة كنتورية لتغطية التغييرات في الخواص الجيوتكنيكية للتربة وعلى أعماق مختلفة لـــتأمين وصف حقيقي ويمكن التعويل عليه لخواص التربة. تم أستخدام خرائط (Google) ونظام التضليع العالمي للاحداثيات (UTM) في الخرائط الكنتورية التي تم رسمها لغرض سهولة ألاستخدام.

الكلمات المفتاحية: خرائط جيوتكنيكية، مدينة النجف، خصائص هندسية للتربة، خطوط كنتورية.

Introduction:

The great developmlent both in construction and infrastructures in An-Najaf city in recent years has led to need of preparing a geotechnical database for this region. Using geotechnical maps saves time and cost of site investigation, especially in reconnaissance phase of investigations. Within the reconnaissance phase the location of the structure will be relocated to more suitable location, number and depths of boreholes are also determined within this phase.

The geotechnical map could be defined as an engineering map for some region, contains the engineering and physical properties of the soil in the covered region. The variation of the properties with depth other dimensions is also presented in the map.

Several studies, of geotechnical properties of soil, were made in different regions of Iraq. (Saba'a, 1987) has studied the distribution of swellable soils in eight governorates of Iraq, including Najaf governorate. (Al-Naimi, 1996) presented a study of soil properties of Baghdad governorate. (Bakir, 1998) presented a study of soil properties of south region of Iraq, geotechnical maps, also presented. (Majeed, 2000) has prepared database of gypsum soils distribution over Iraq. (Al-Ani, 2001) presented a geotechnical maps of Diyala governorate. (Al-Jebori, 2002) has presented geotechnical maps for Babylon governorate. (Al-Shakerchi, 2006) has summarized the geotechnical data of An-Najaf city. (Al-Shekerchi & Al-Khuzaei, 2011) have presented sets of geotechnical maps for four Iraqi governorates, Baghdad, Diyala, Wasit, and Babylon.

In the present paper a geotechnical maps of An-Najaf city were prepared using

the well-known commercial software (SURFER11), which provide the ability of producing contour maps according to fed data. The geotechnical data were collected from different site investigation reports which cover the area under consideration.

Region Description, Topography and Geology:

The area under consideration of An-Najaf city is located with the coordinates listed in the Table (1). Figure (1) shows the area under consideration. An-Najaf city is located in Plateau region with attitude about (60-55m). The slopes are flat and gradual toward western north, north, east, southern east, and south, while its very steep and forming natural edge toward west and southern west as shown in Figure (2) (Yousif, 2004). The stratigraphic of study area consisting of successive rock formations with sedimentary origin. Surface exposes the following layered distributions, from the oldest: (Jassim and Goff, 2006;Hasan, 2007):

1. Tertiary Deposits:

A. Dammam formation, which is belong to Eocene epoch, it is spreading over the middle southern part of region under consideration. It contains chalky lime stone, clay stone, granite, and marl stone.

B. Euphrates formation, it belongs to lower Miocene age. This formation represents rocky plain, covered with shallow lakes. It contains a cover from sand stone, lime stone, and gypsum marl stone.

C. Al-Fat'ha formation, it belong to middle Miocene epoch. It forms narrow strip to the west of An-Najaf and Kerbalaa, also to the north of An-Najaf fan. It contains different deposits periods of limy clay stone, marl, gypsum, and lime stone.

D. Injana formation, it belongs to upper Miocene epoch. It contains several types of components, which are, sand stone (fine to coarse particle size), hard alluvial stone, and many types of clays.

E. Dibdibba formation, it belongs to Pliocene and Pleistocene epochs, it covers the area between Kerbalaa and An-Najaf, with thickness about (94m). It is composed of sand, fine gravels, and fine lime stone.

2. Quaternary Deposits:

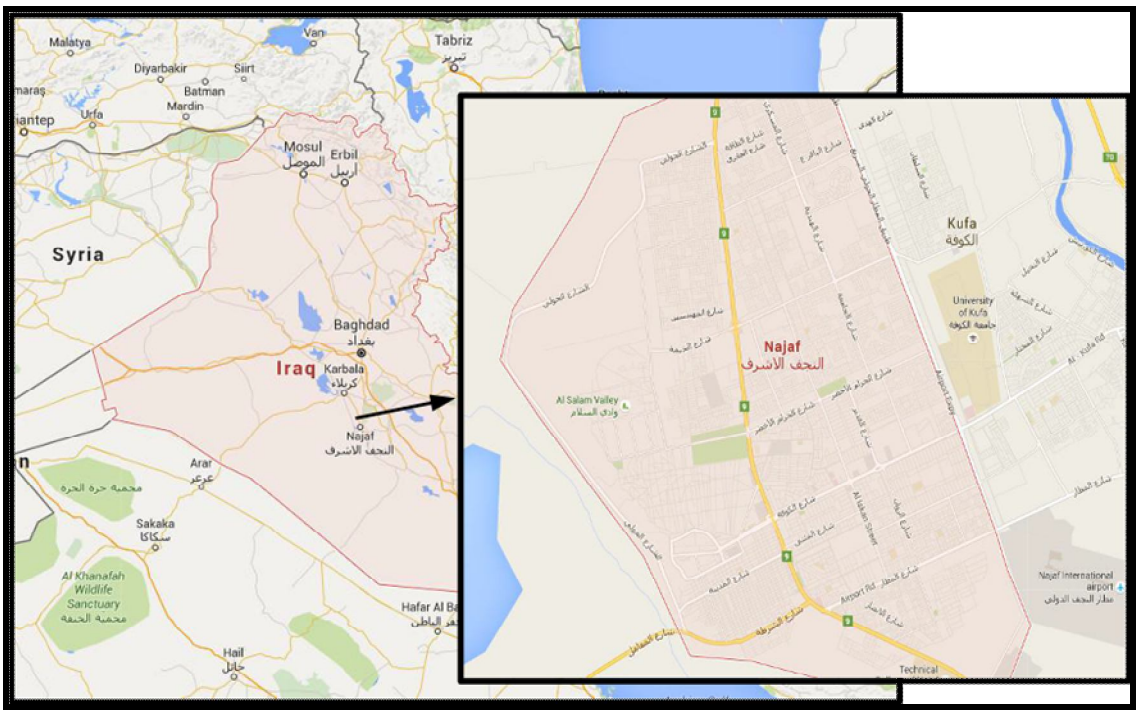
It covers the Euphrates river strip, beginning from Al-Musaiyeb to Al-Manathera. It composed of following:

A. Pleistocene deposits, composed of alluvial fans, which contains gravel, sand, and alluvial.

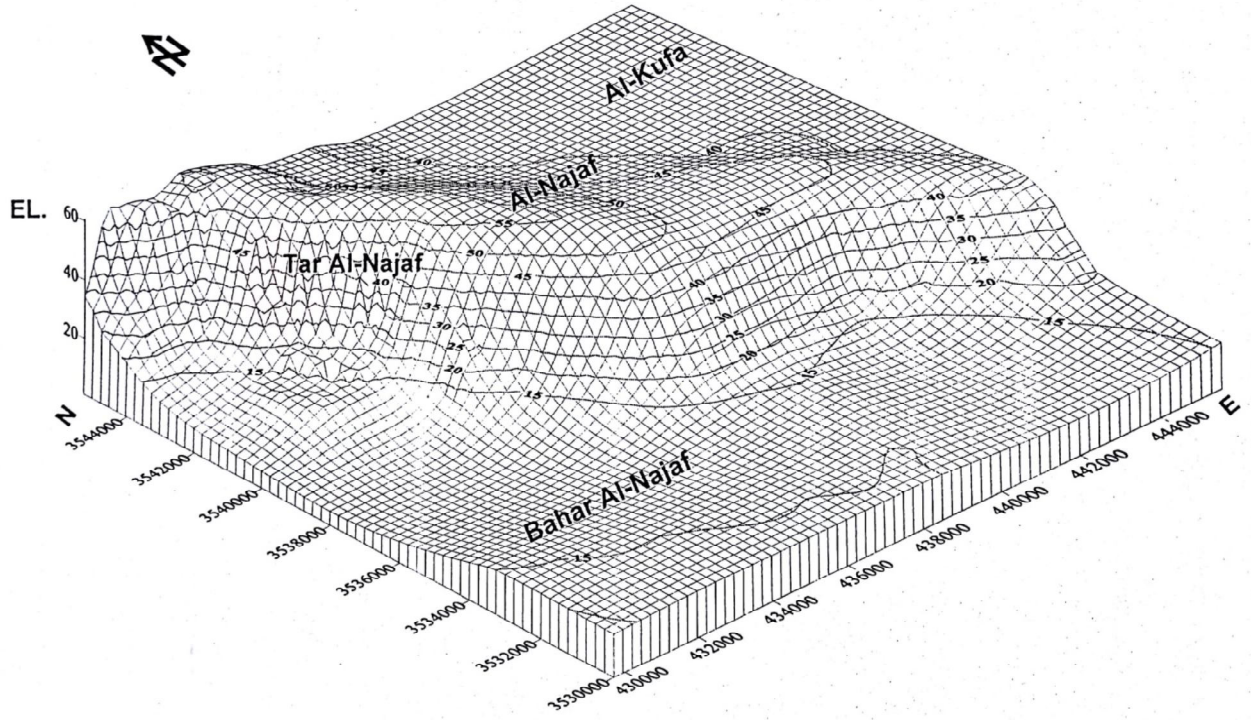
B. Holocene deposits, consisting of Euphrates flood plain deposits, valley basin deposits, and some sand dunes.

Table (1) Coordinates of Region Under Consideration.

No.	N	E
1	3537949.50	435113.89
2	3537949.50	441702.02
3	3549401.25	435113.89
4	3549401.25	441702.02



Figur (1) An-Najaf City Map, Iraq. (Google Maps, 2015)



Figur (2) 3-Dimensional map of elevations of An-Najaf region. (After Yousif, 2004).

Geotechnical Maps:

The data were collected from site investigation reports, which covers the area under consideration, these reports were made by different sides. An-Najaf city maps used in the present reseach work were taken from Google Maps, the global coordinates were putted in the axis of the maps, also the main landmarks were presented on the maps. Seven depths were taken to present the geotechnical properties

on. These depths were selected as (1.5, 2.5, 5, 7.5, 10, 12.5, and 15 m), these depths are suitable for foundation of small and meduim construction prjects. The soil within the first (1.5 m) depth was ignored due to prbability of existing a fill soil by human action.

The studied geotchnical properties were as following, according to the availability of data within the collected geotechnical investigation reports:

1. Physical properties of soil:
    a) Grian size analysis.
2. Engineering Properties of Soil:
    a) Standard Penetration Test (SPT).
    b) Angle of Internal Friction (Ø).
3. Chemical Properties of Soil:
    a) Sulphate Content (SO_3%).
    b) Gypsum Content (Gyp. %).
    c) Carbonate Content ($CaCO_3$.%).

A Forty Nine (49) Maps were created for the soil properties across the selected depths. Countor interval, for all countor maps, was selected as (0.01). In some maps there are areas not coverd by countor lines due to unavilablity of data. The background of the all countor maps represents Najaf city map fitted with the coordinates of the countor map. Universal Transverse Mercator coordinate system (UTM) was used in all countor maps, and it appears along the axis of the maps. Countor Maps from (1 to 14) present the grian size distribution of the soil, fines percent and sand percent are both presented in differnt maps. Maps from (15 to 21) present the Standard Penetration Test (SPT) values. Due to different methods of SPT test correction, uncorrected values of SPT have been presented herein. Maps from (22 to 28) present the Angle of Internal Friction (Ø) values. Maps from (29 to 49) present the chemical properties of the soil, Sulphate content (SO_3%), Gypsum content, and Carbonate content ($CaCO_3$.%), respectivly.

An-Najaf City Soil Description:

In general, sand represents from (50% to 85%) of the soil composition, with few layers of clay and silty clayey soil in different depths. High values of SPT values, which exceeds (50 blows), are dominated whithin this region. Dense to very dense sand, and cemented sand are the most existing soil conditions. Angle of Internal friction (Ø) exceeds (35^o) in most of the region. The bearing capacity form SPT valuse and exceeds (10 Ton/m^2) in most studied region.

Sulphate content reaches to (10%). Gypsum content is very high, it reachs to (25%) in some locations.

Conclusions:

1. Due to existance of dense to very sand, and cemented sand, with SPT values exceeds (50) blows in all over the region, driven pile shall be not recommended in use. Partial Preboring (Predrilling) techinique of pile driving could be used according to feasibility study. (Peck *et.al*., 1974; Al-Shakarchi, *et. al*., 1985, in Arabic).
2. Due to high sulphate content, foundation concrete should be protected effectivly againest the corrsion caused by it. Sulphate resistance cement type, and sulphate resistance additives of concrete shall be recommended.
3. Due to high Gypsum content, gaviteis forming, whithin the soil, shall be considered in foundation design. Gypsum solution due to water table and high stresses could cuase a serious structural problems. (Peck *et. al*., 1974), (Mahmood, *et. al*., 2010, in Arabic).

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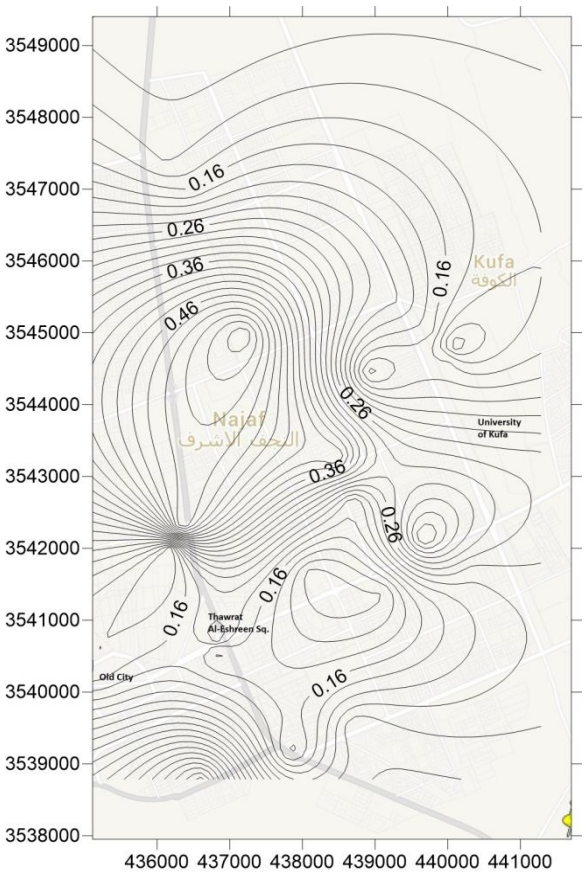
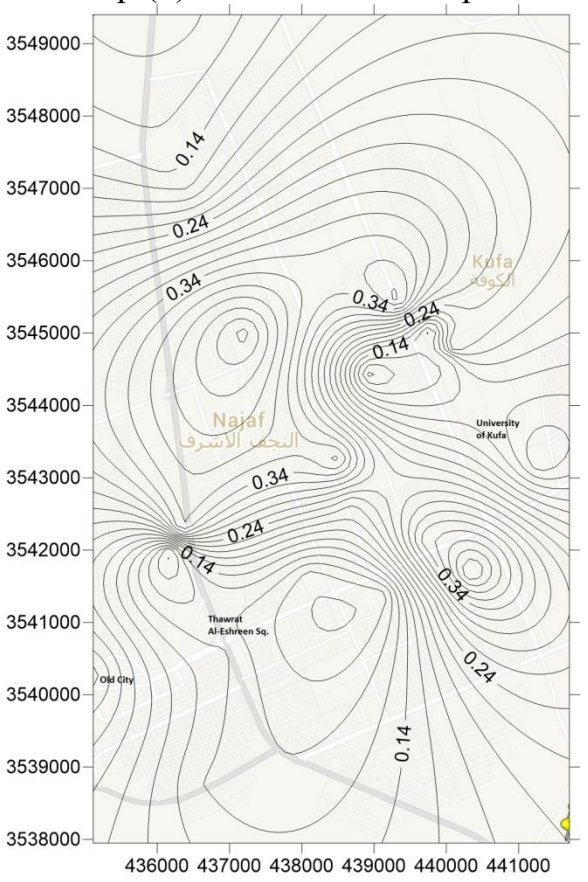


Map (1) Fines at 1.5 m Depth.



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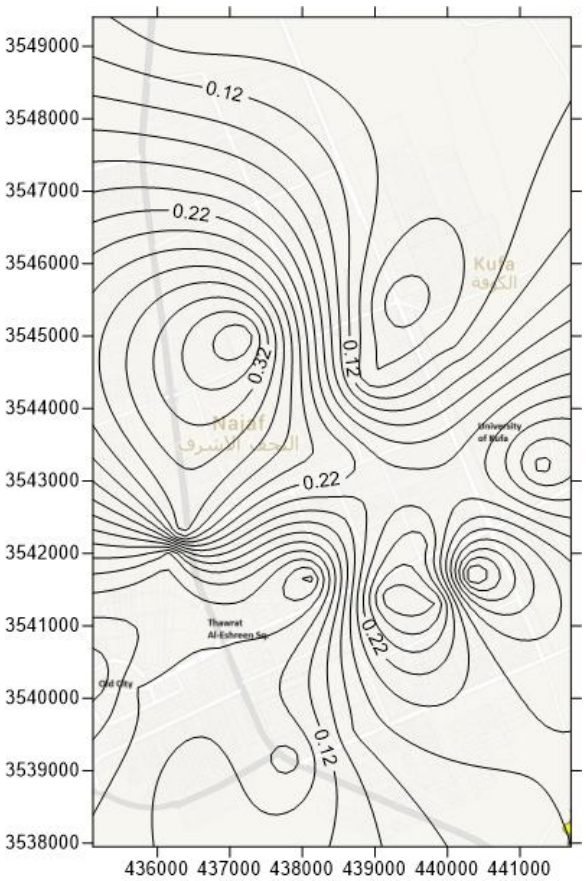

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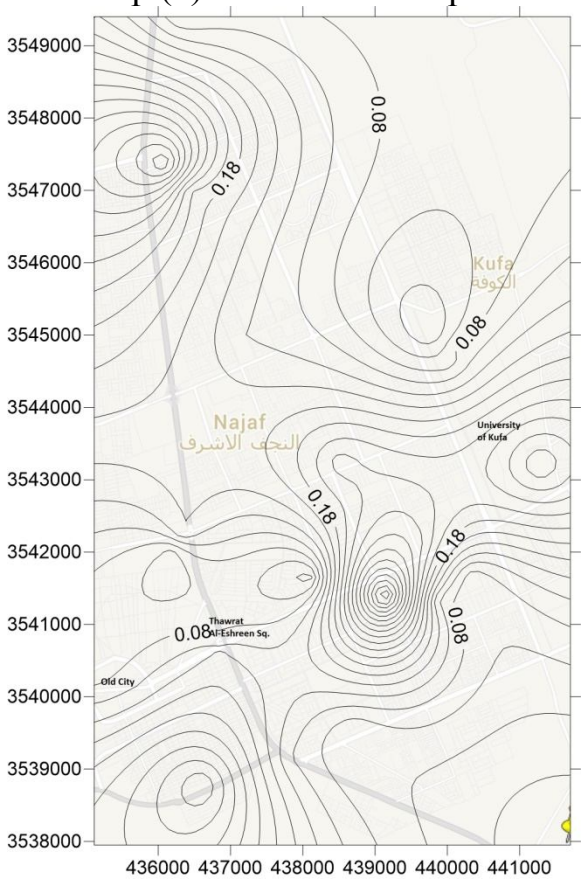

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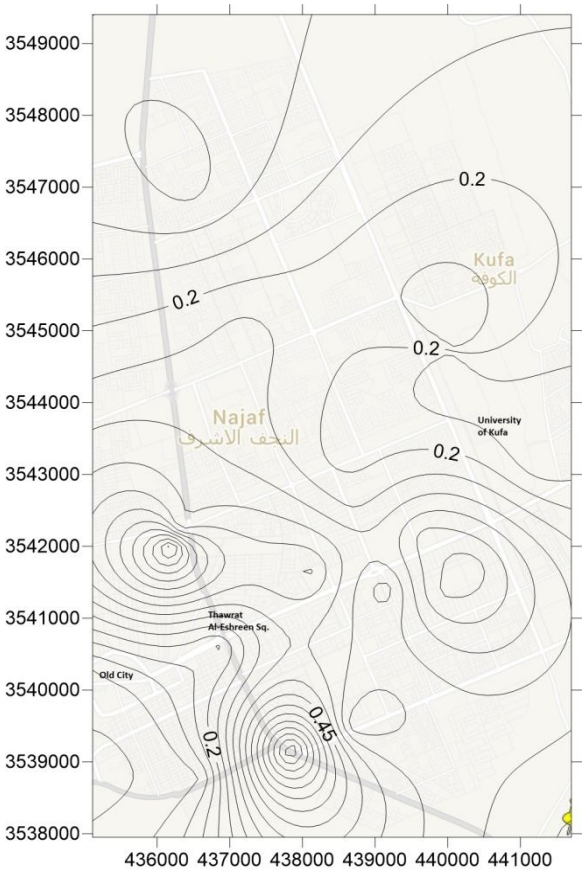

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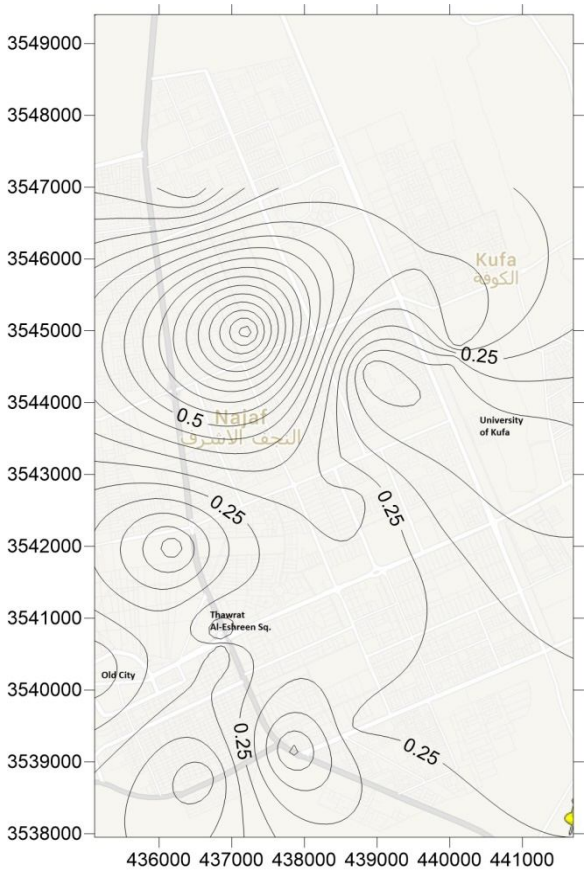

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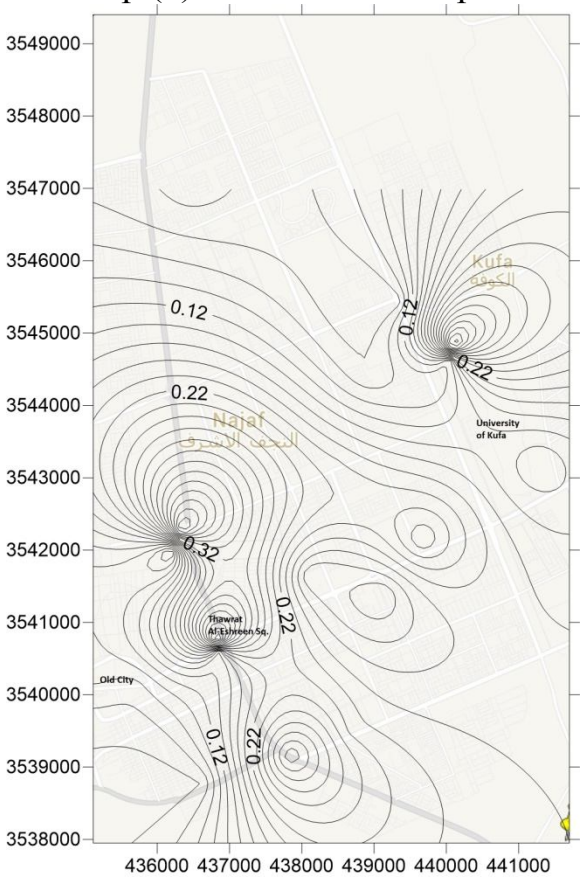

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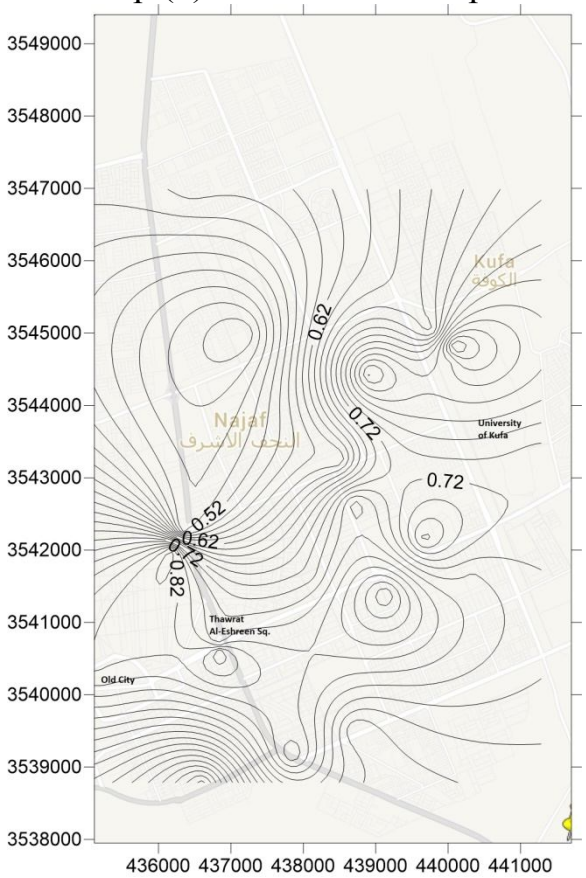
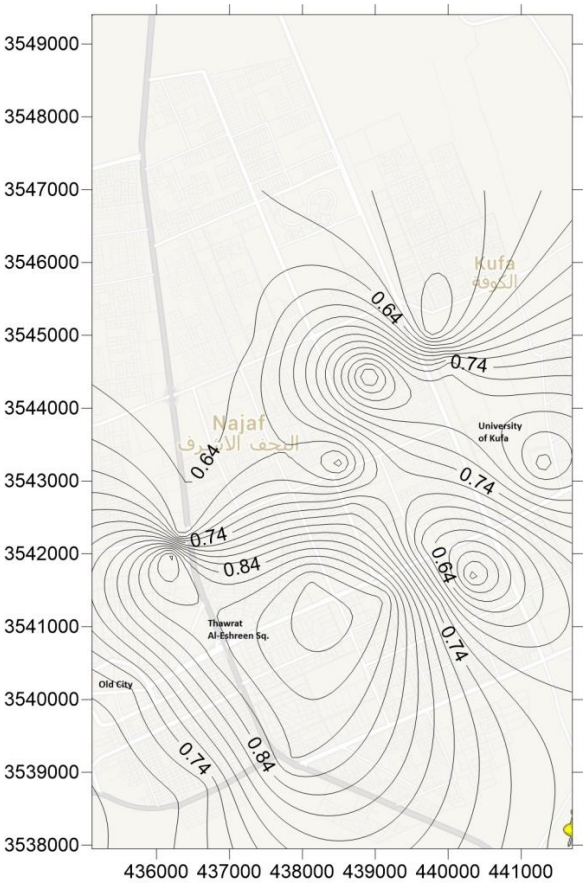


Map (8) Sand at 1.5 m Depth.



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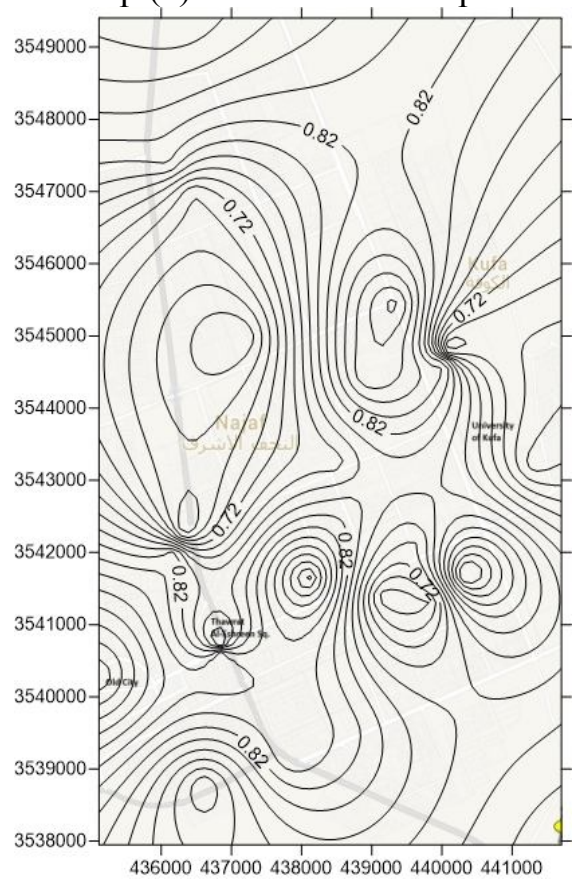

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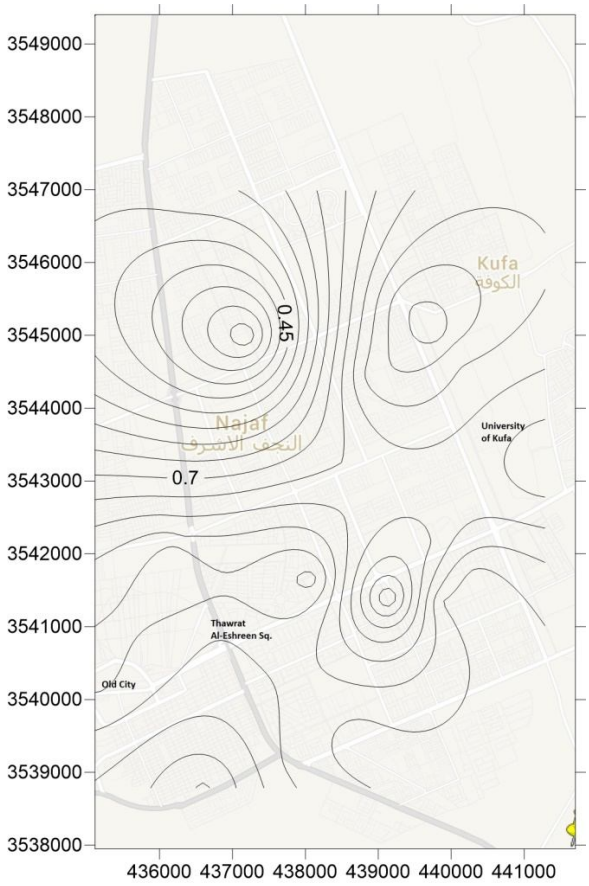
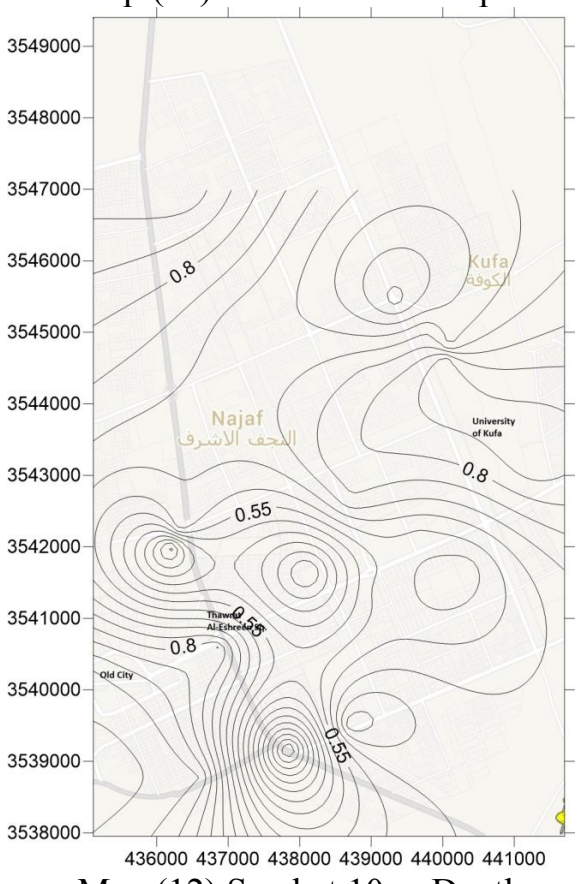
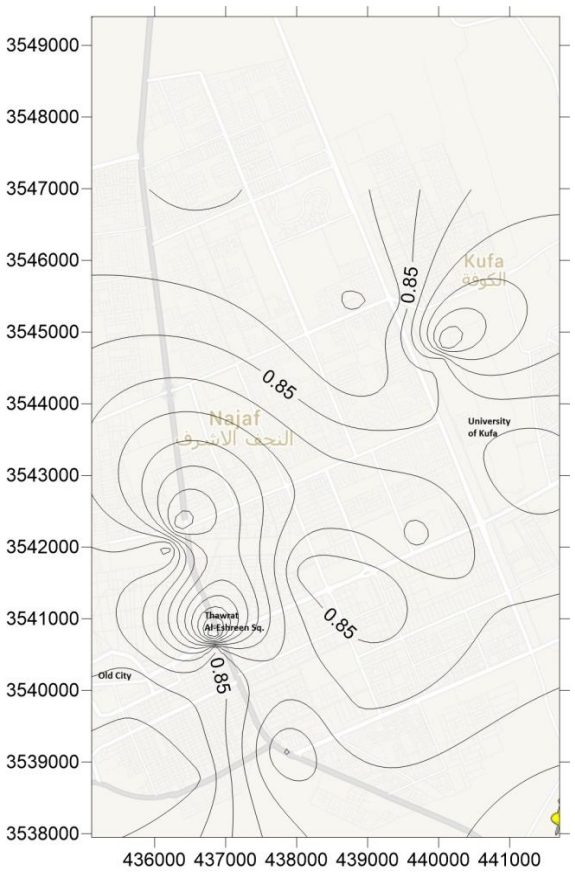


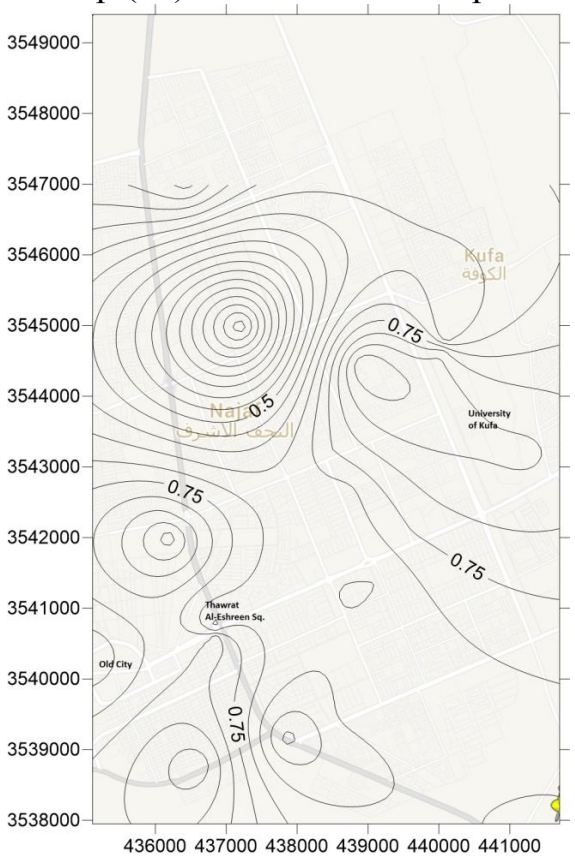
Map (11) Sand at 7.5 m Depth.



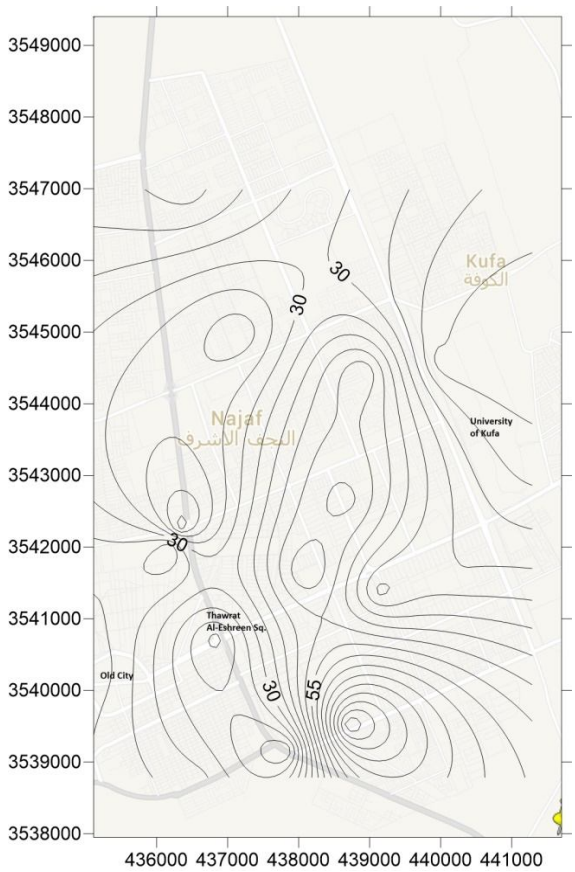
Map (12) Sand at 10 m Depth.



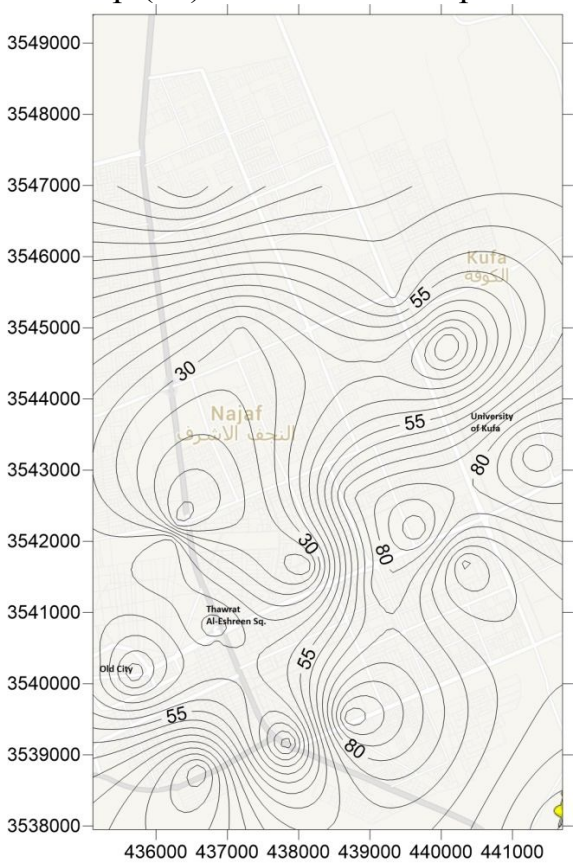
Map (13) Sand at 12.5 m Depth.



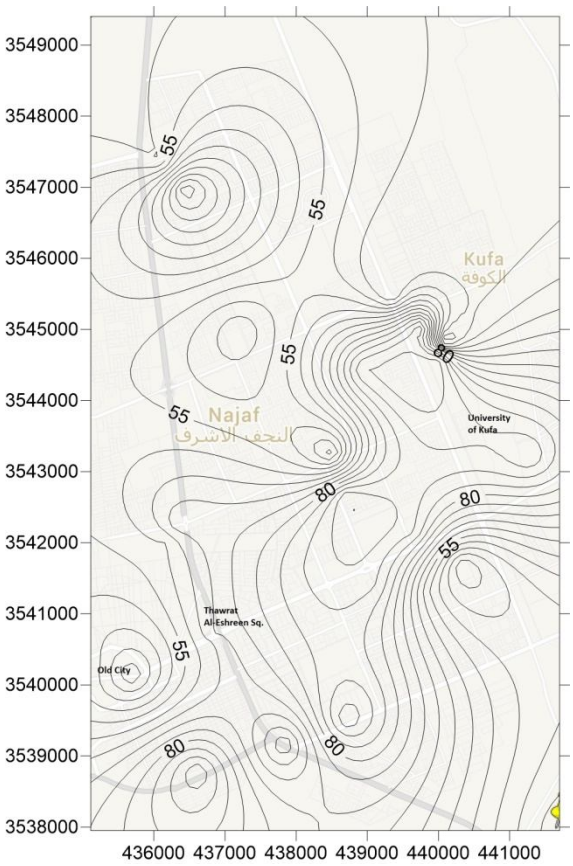
Map (14) Sand % at 15 m Depth.



Map (15) SPT at 1.5 m Depth.



Map (16) SPT at 2.5 m Depth.



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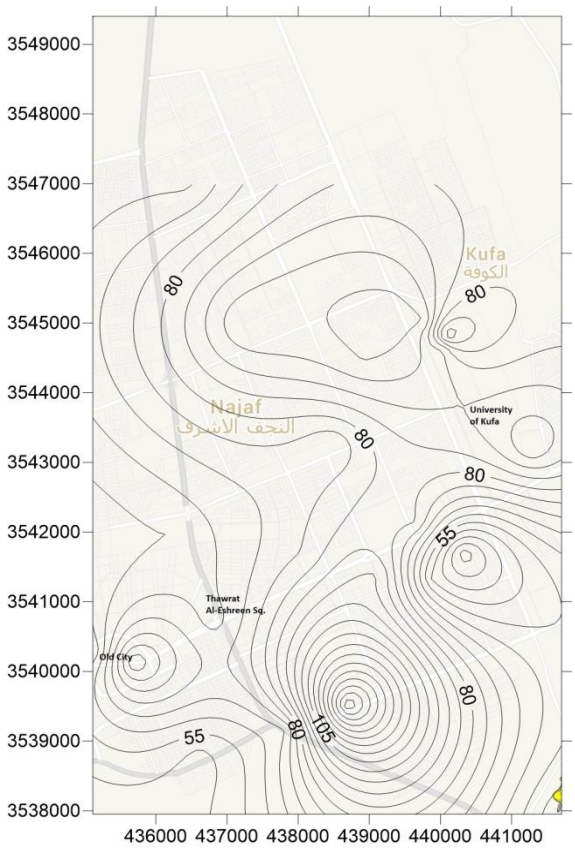

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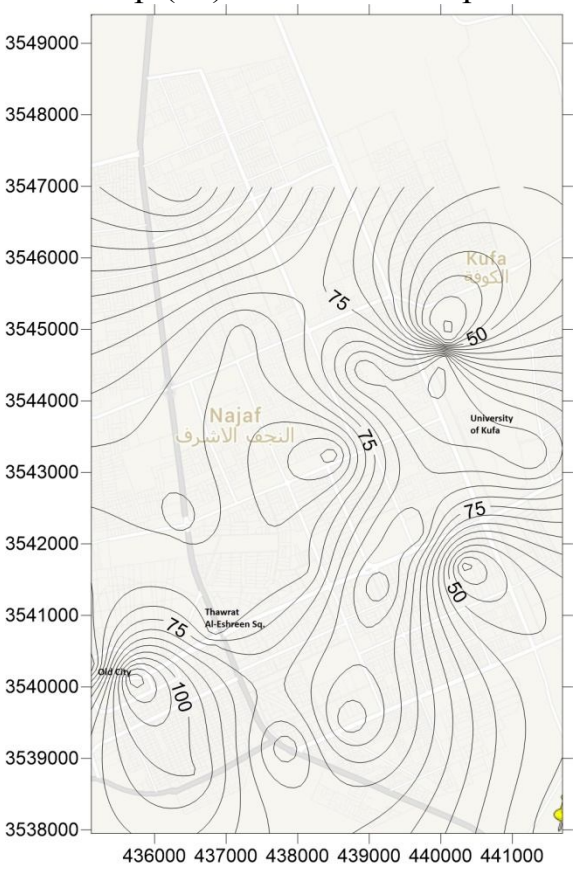

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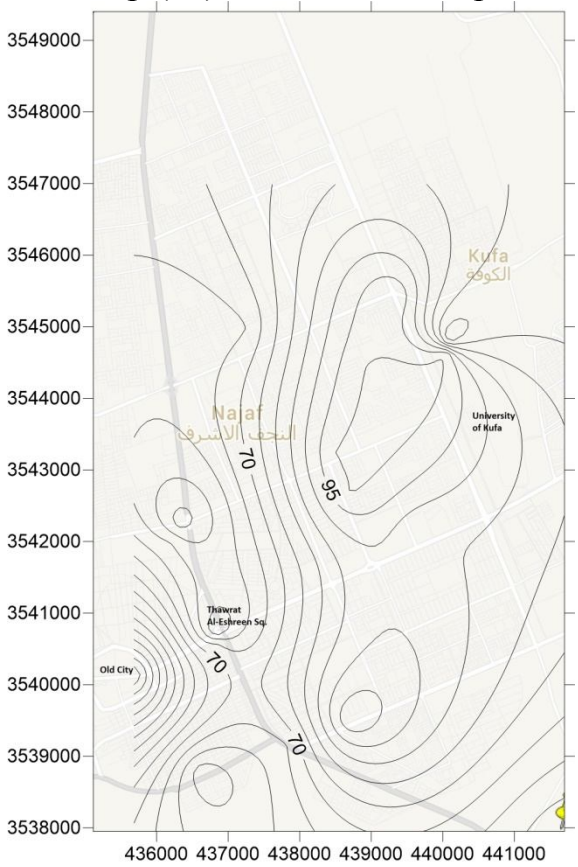
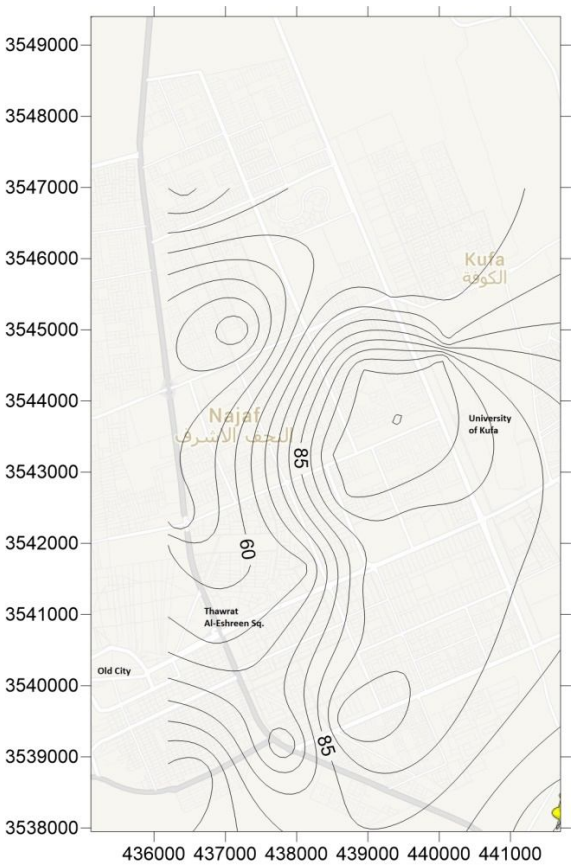


Map (20) SPT at 12.5 m Depth.



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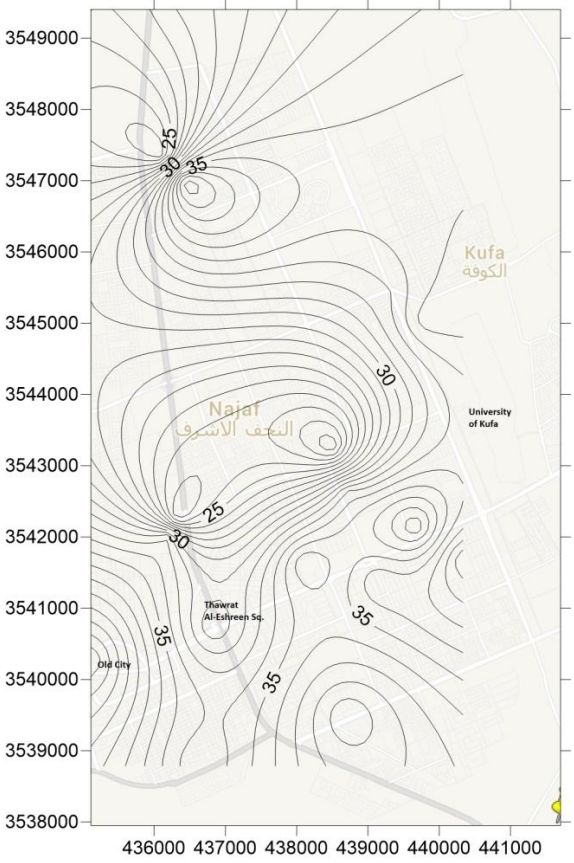
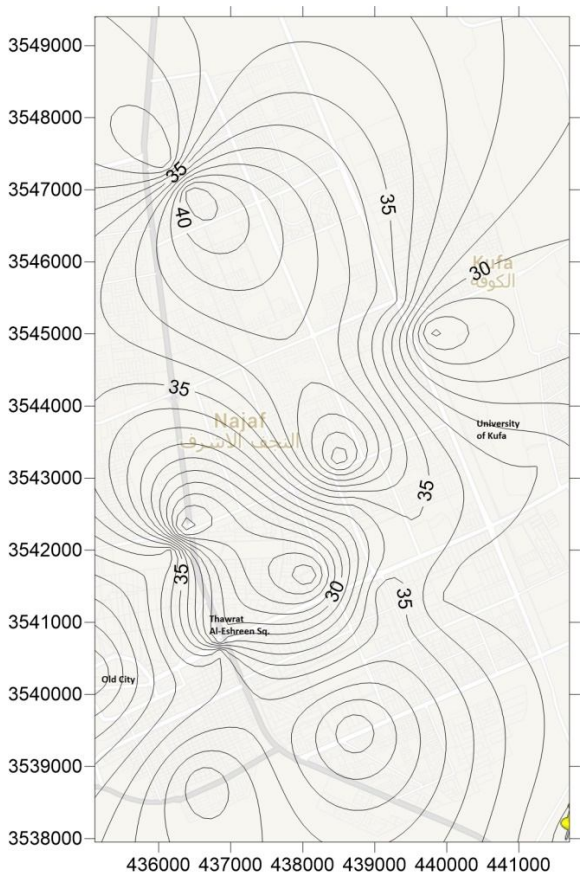
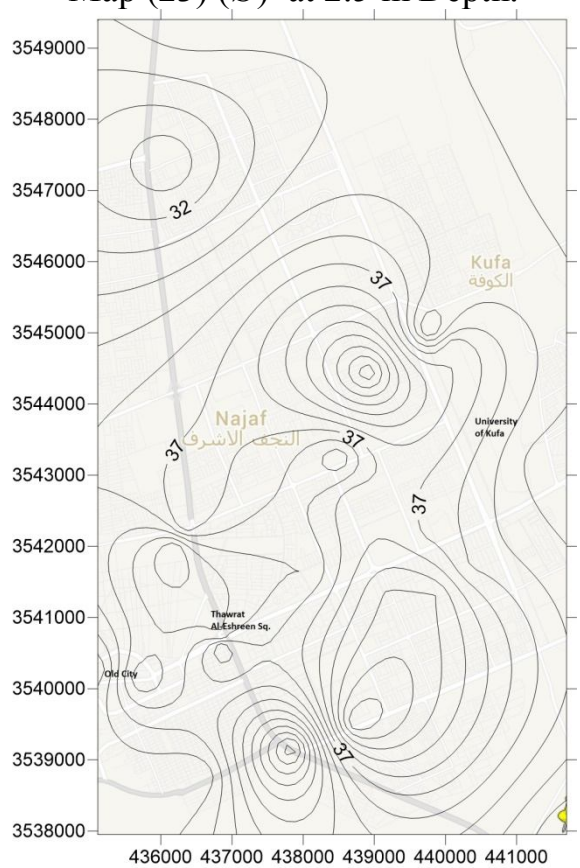


Map (22) (Ø) at 1.5 m Depth.



Map (23) (Ø) at 2.5 m Depth.



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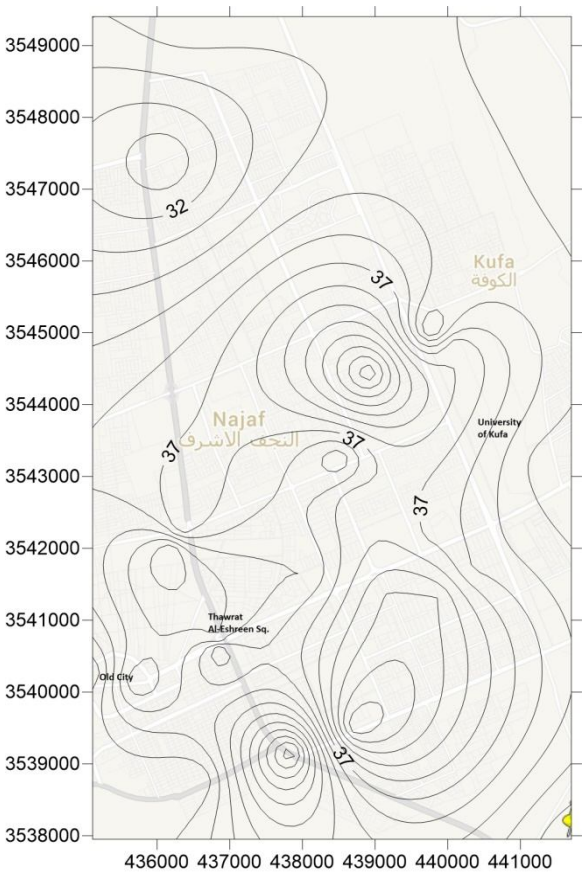
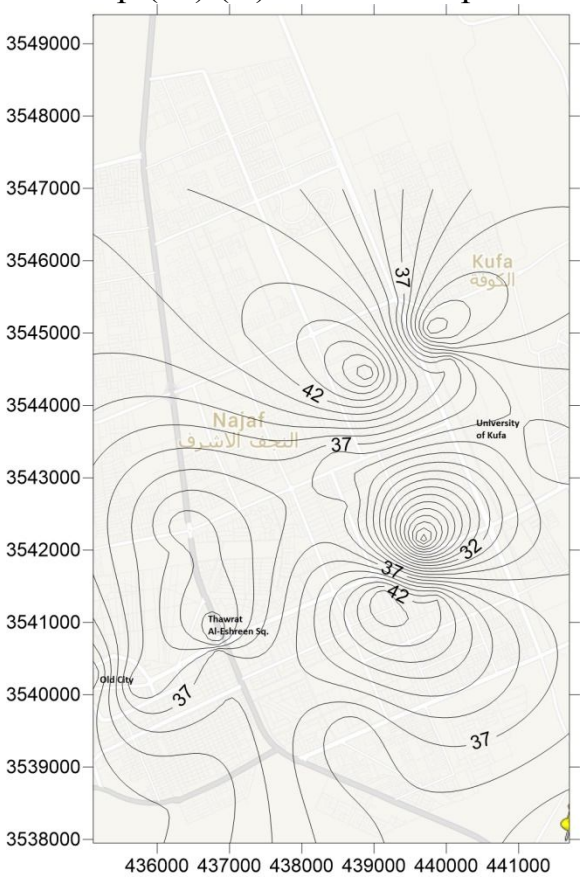
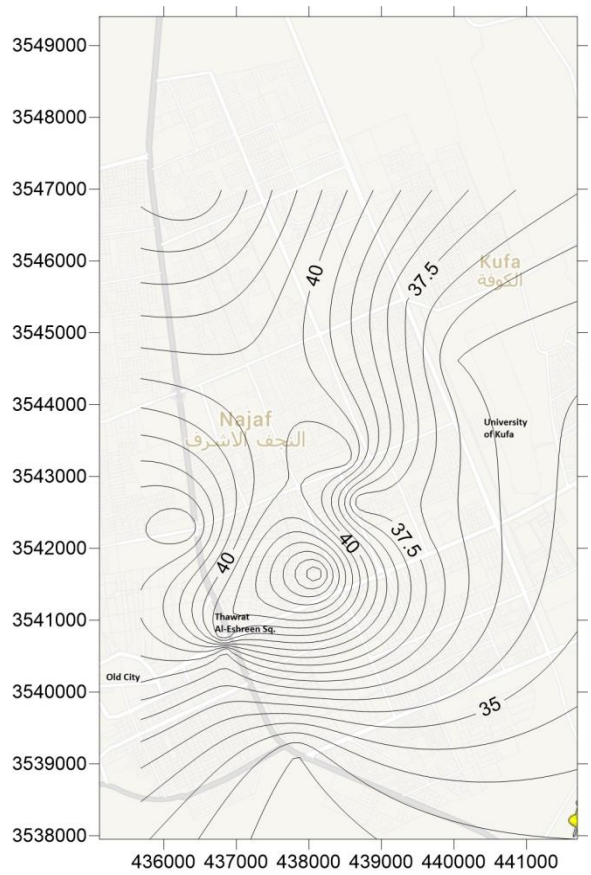


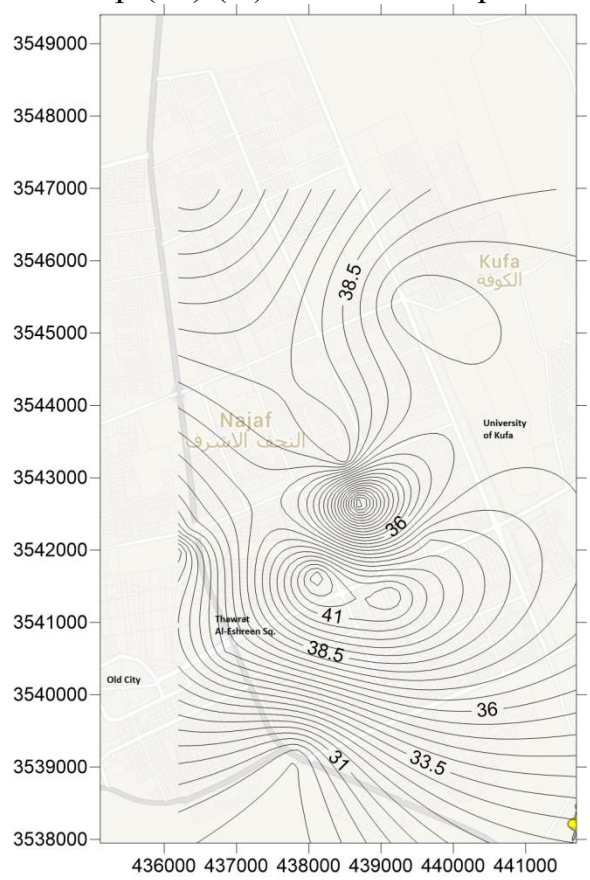
Map (25) (Ø) at 7.5 m Depth.



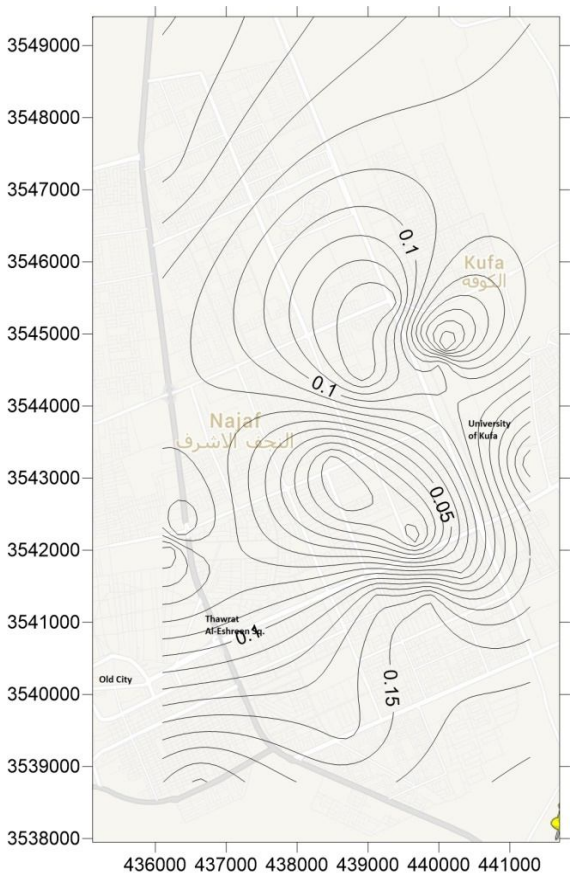
Map (26) (Ø) at 10 m Depth.



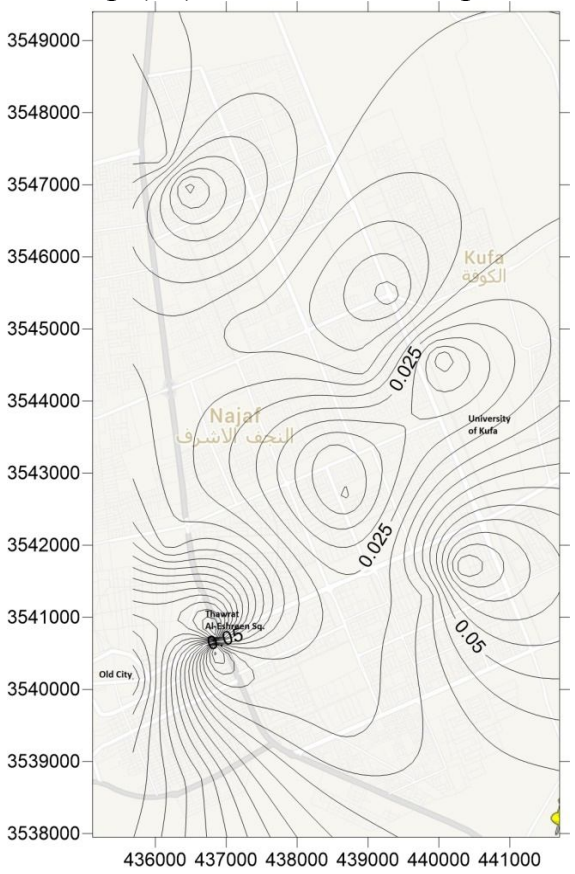
Map (27) (Ø) at 12.5 m Depth.



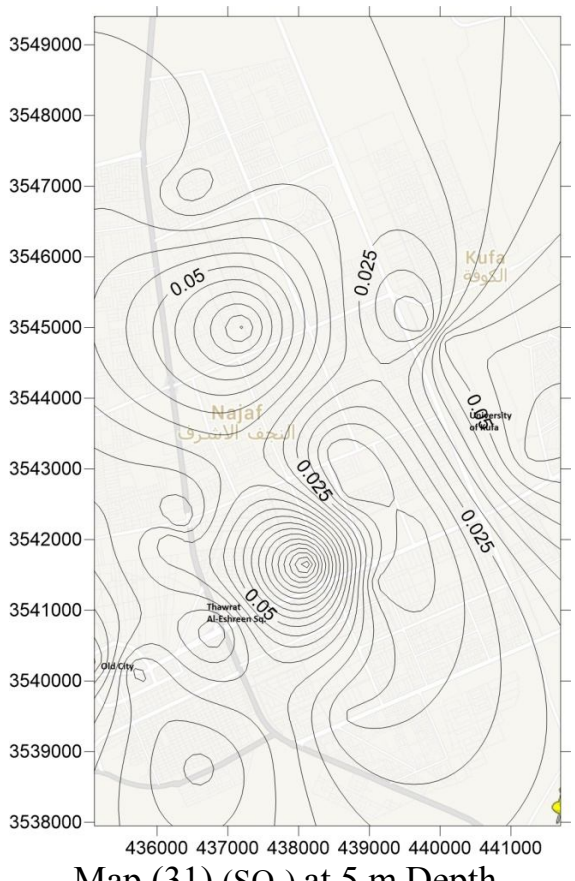
Map (28) (Ø) at 15 m Depth.



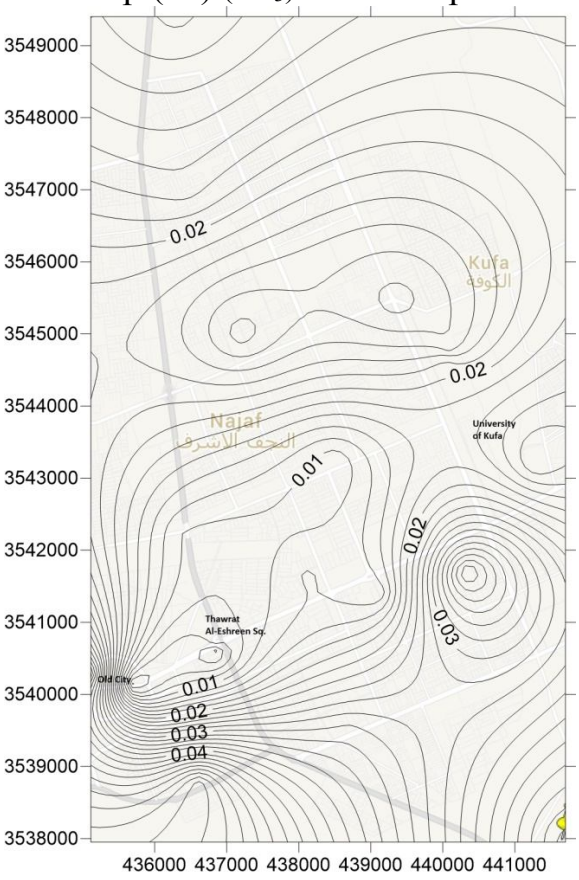
Map (29) (SO_3) at 1.5 m Depth.



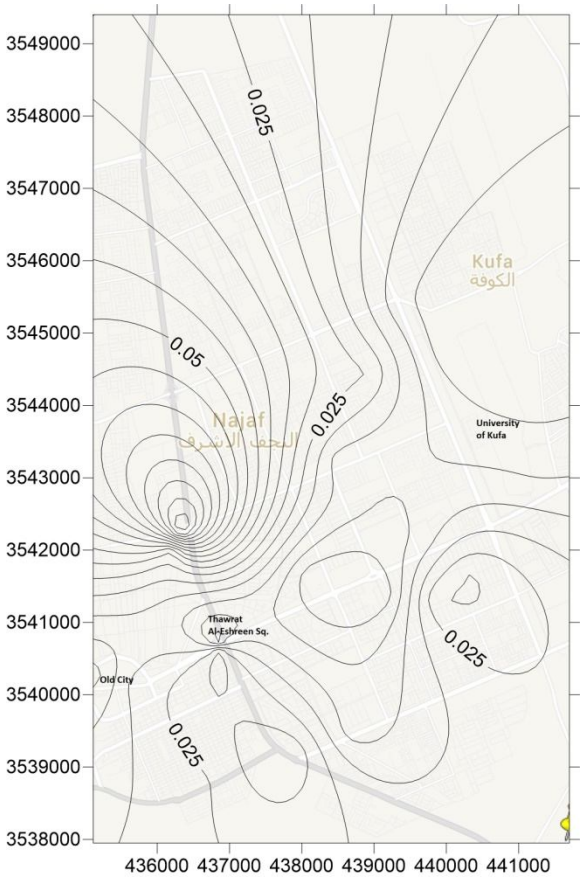
Map (30) (SO_3) at 2.5 m Depth.



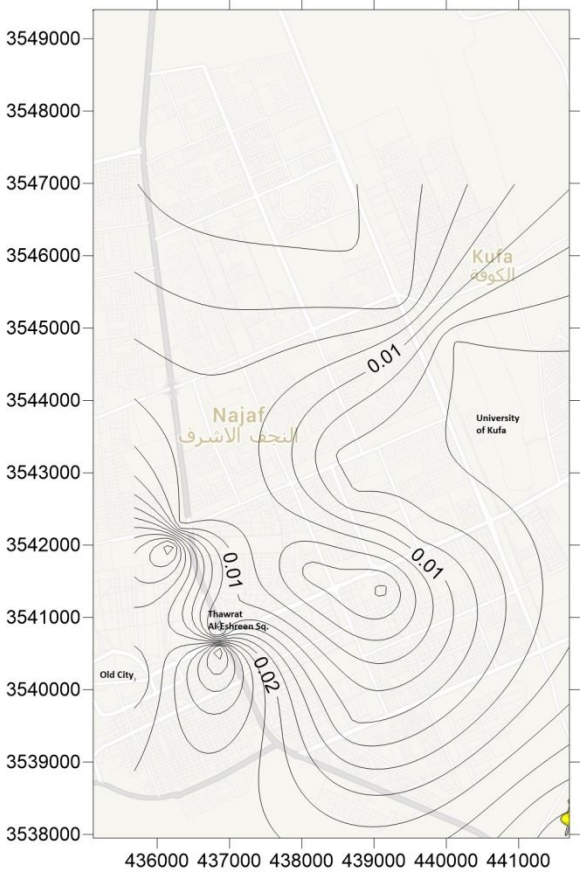
Map (31) (SO_3) at 5 m Depth.



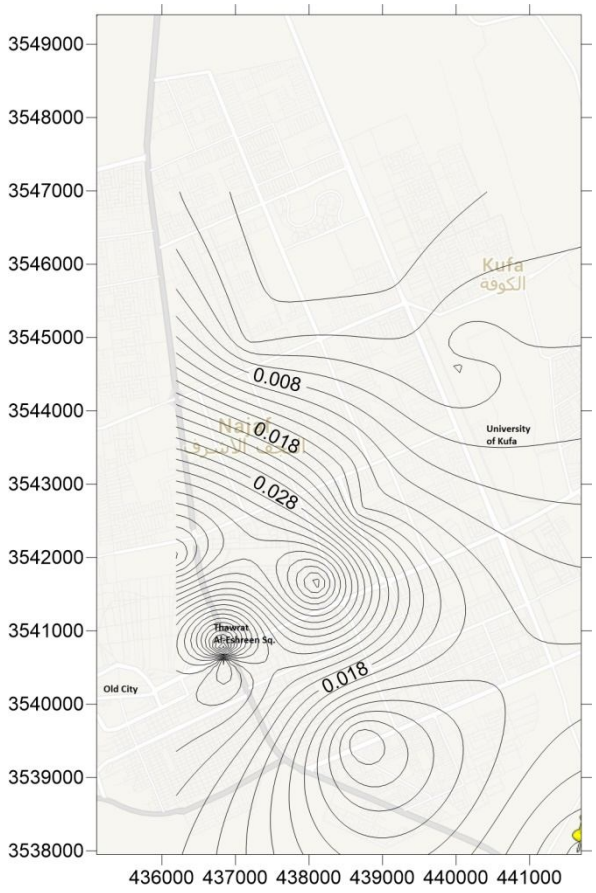
Map (32) (SO_3) at 7.5 m Depth.



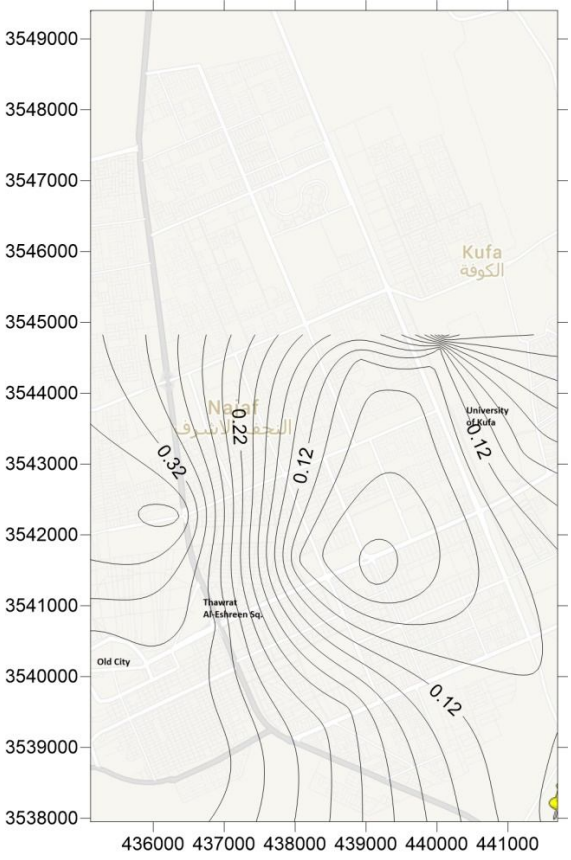
Map (33) (SO_3) at 10 m Depth.



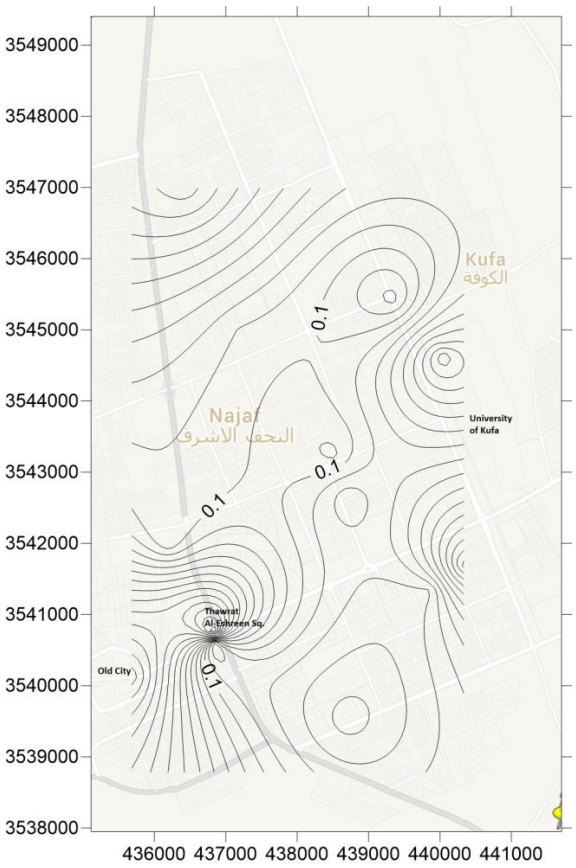
Map (34) (SO_3) at 12.5 m Depth.



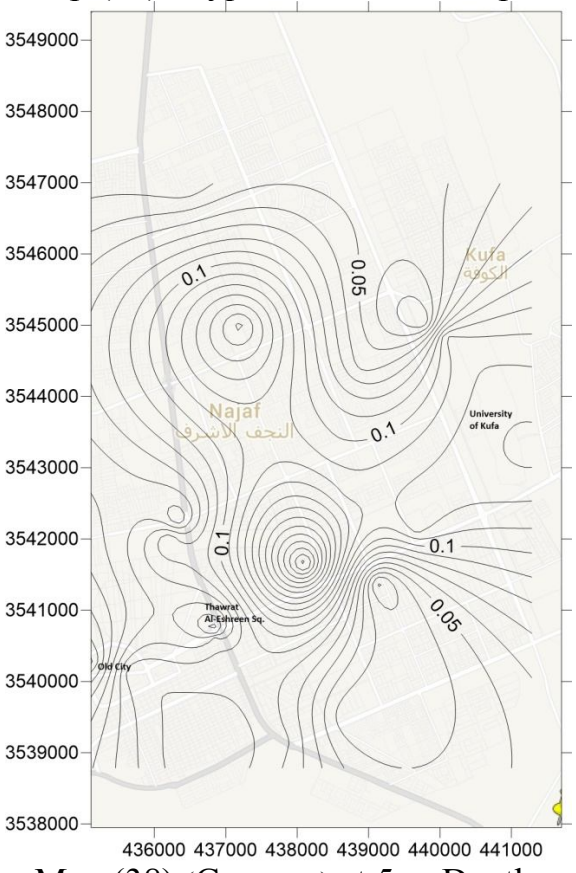
Map (35) (SO_3) at 15 m Depth.



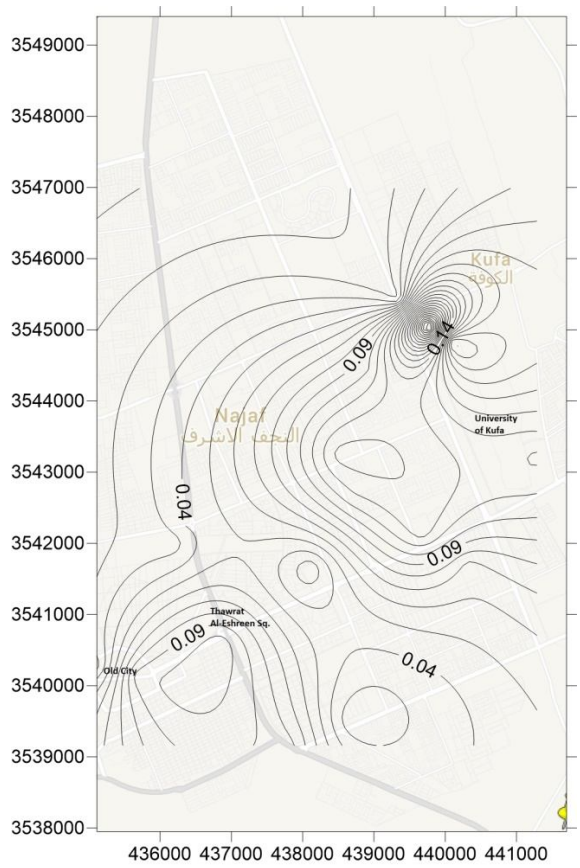
Map (36) (Gypsum) at 1.5 m Depth.



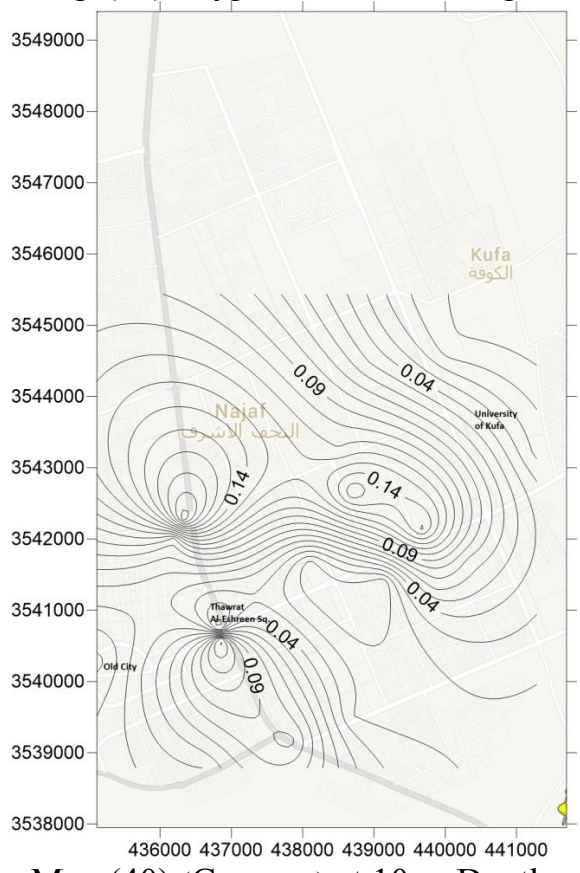
Map (37) (Gypsum) at 2.5 m Depth.



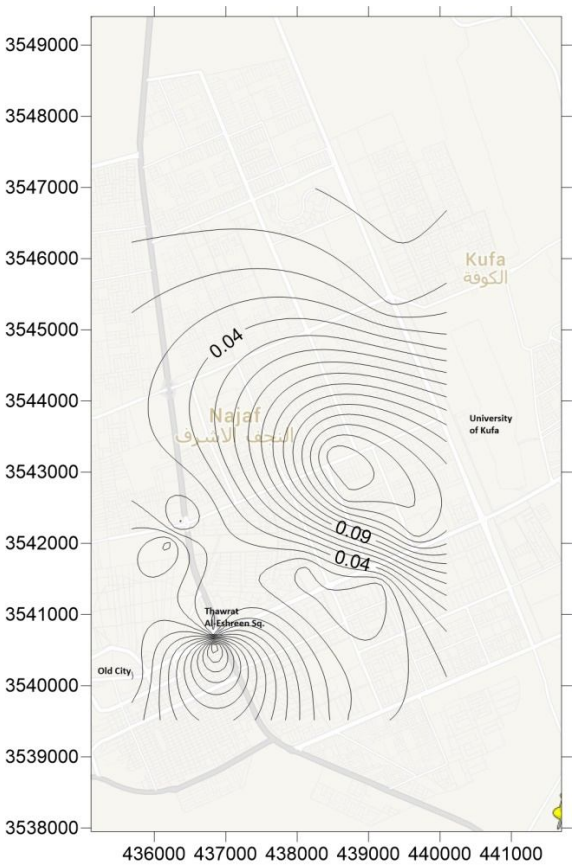
Map (38) (Gypsum) at 5 m Depth.



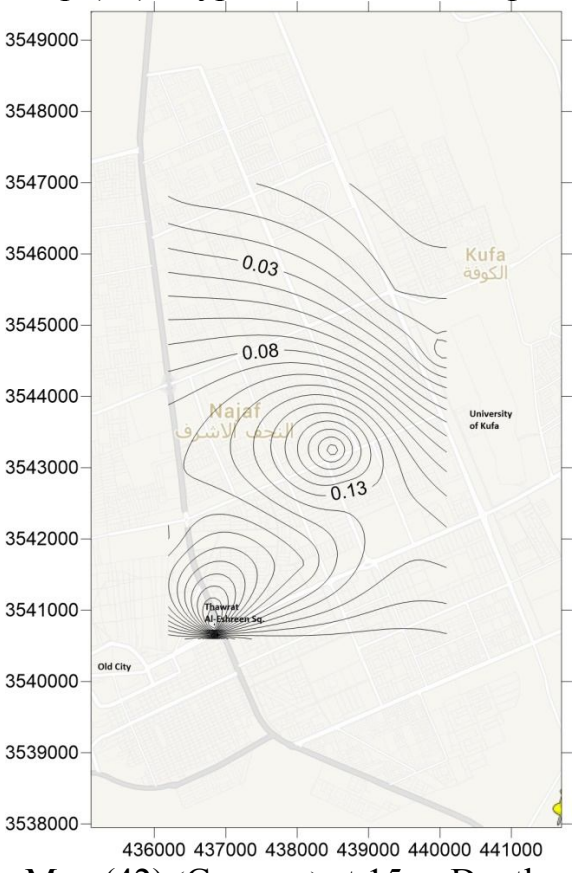
Map (39) (Gypsum) at 7.5 m Depth.



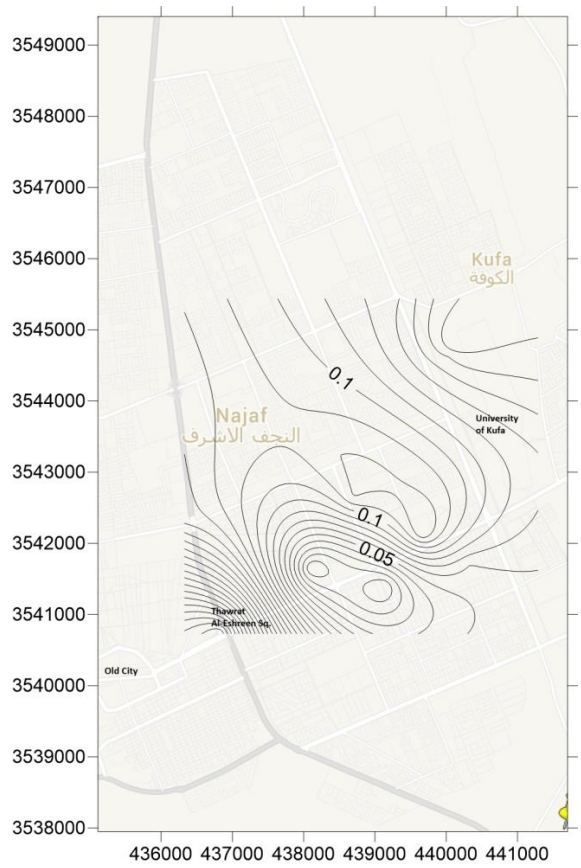
Map (40) (Gypsum) at 10 m Depth.



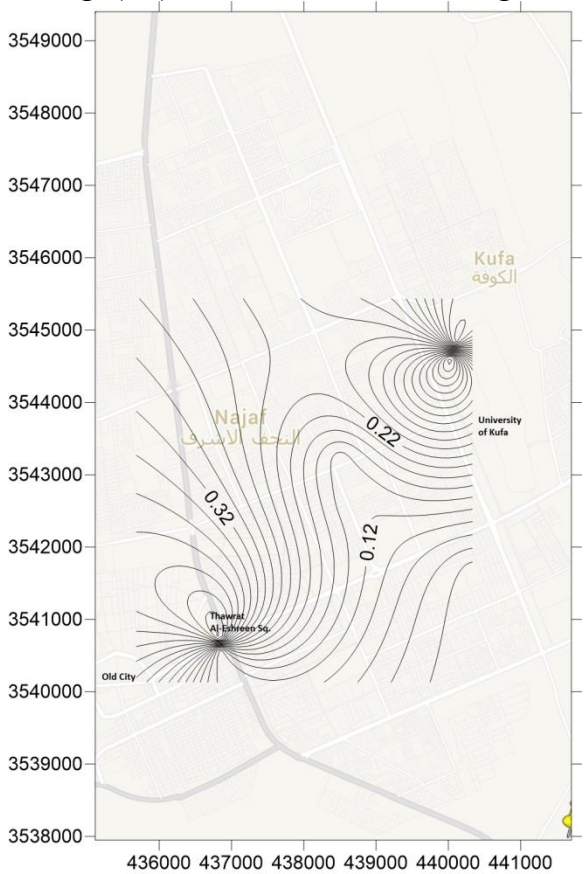
Map (41) (Gypsum) at 12.5 m Depth.



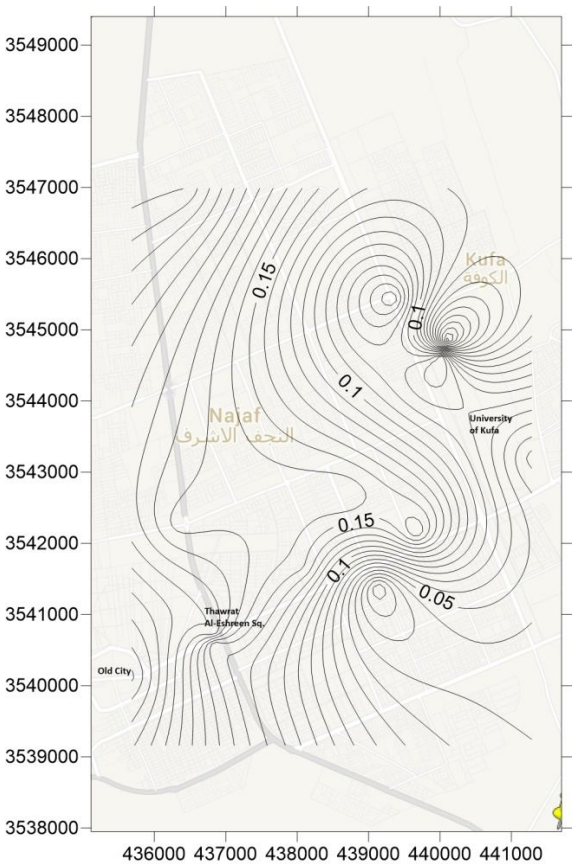
Map (42) (Gypsum) at 15 m Depth.



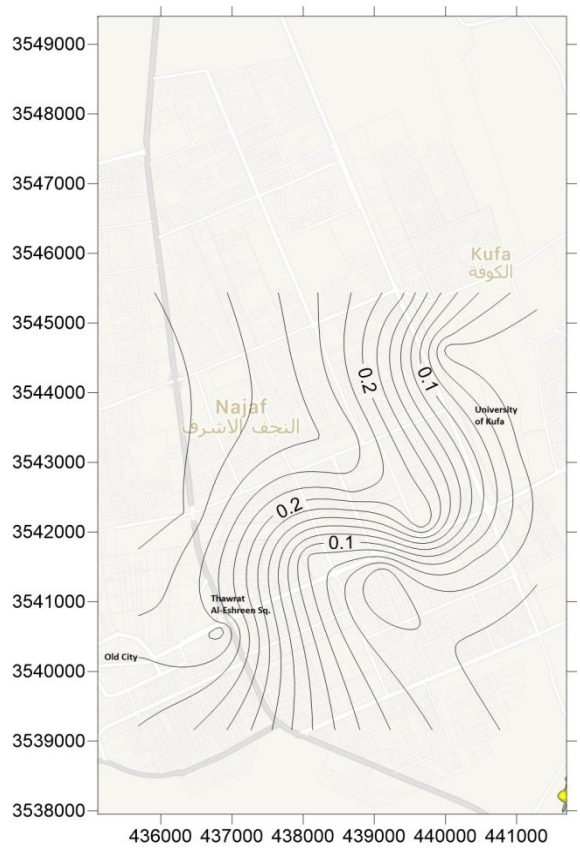
Map (43) ($CaCO_3$.) at 1.5 m Depth.



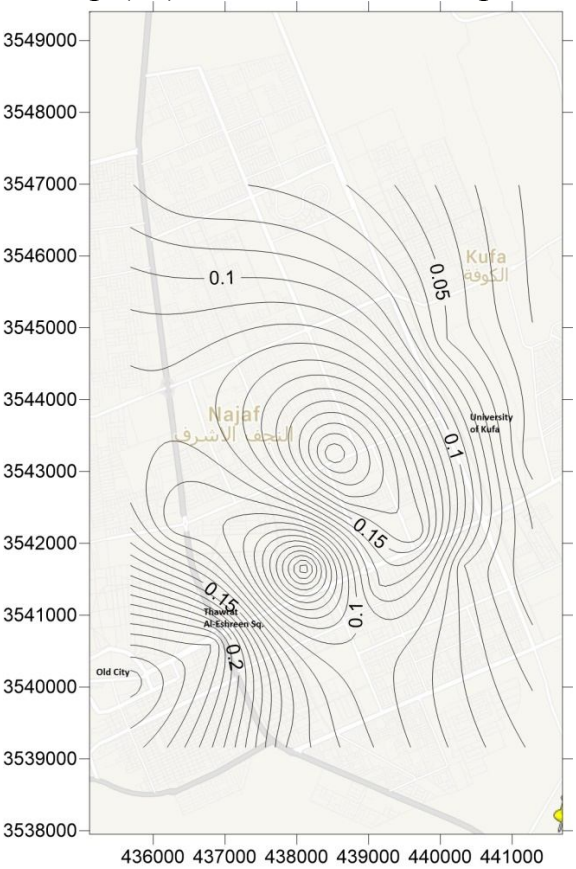
Map (44) ($CaCO_3$.) at 2.5 m Depth.



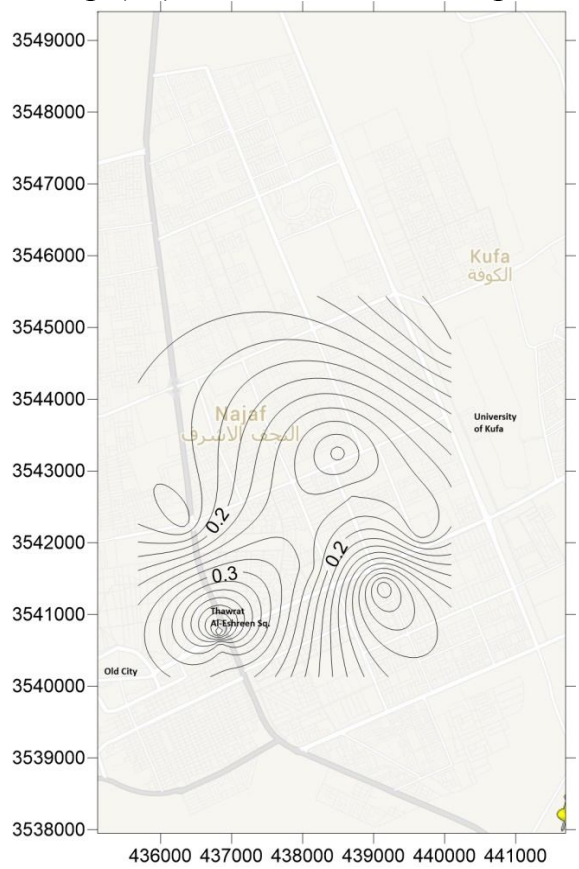
Map (45) ($CaCO_3$.) at 5 m Depth.



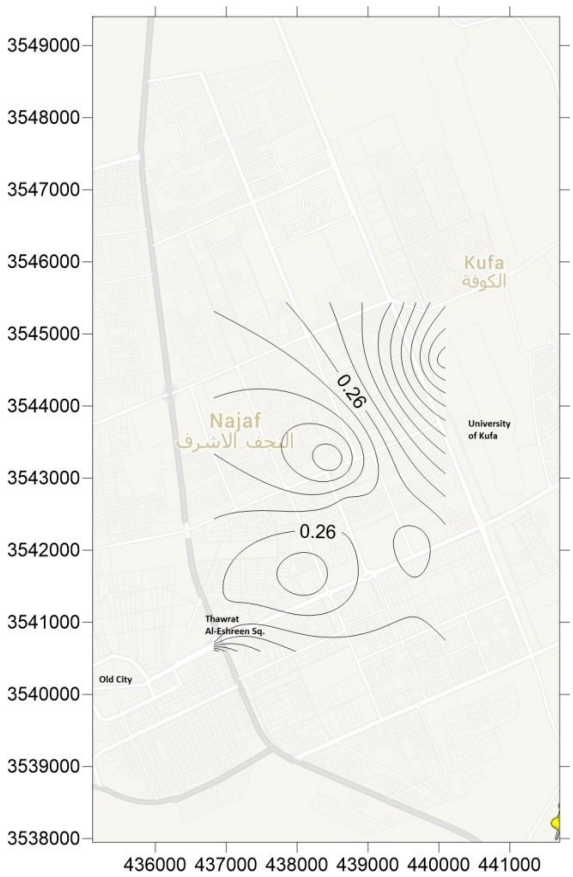
Map (47) ($CaCO_3$.) at 10 m Depth.



Map (46) ($CaCO_3$.) at 7.5 m Depth.



Map (48) ($CaCO_3$.) at 12.5 m Depth.



Map (49) ($CaCO_3$.) at 15 m Depth.