Effects of Soil Depth And Rivers Slop on Total Boron Content In Some of The Iraqi Provinces

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Abstract
Aiming to study effects of soil depth and rivers slop on total boron concentration in Middle Euphrates River Reion that represent in the sedimentary plain, soil pedon samples of cultivated territory that adjacent to rivers were taken. These regions are located in provinces of Karbala, Babylon, Najaf, Diwaniyah, and Al-Muthana. Ten soil pedon were taken of soils that adjacent to the main Euphrates River, the Al-Hilaa, and the AL-Daghara Rivers in these provinces. Soil pedon of soils that on the banks or close to the main Euphrates River were taken of counties of Twarije, Kufa, Gamas, and Al-Samawa. In the same way, soil pedon of Missaib, Hashmiah, Diwaniyah, and Rumitha are adjacent to the Hilla River and soil pedon of Al-Daghara and Affak belongs to the area of Al-Daghara River. Results show a reduction in total boron concentration for all of the tested soil pedon directly related with the depth. Aggregate boron concentration values are the highest at the surface layer and reduce as going depth except for soils of Al-Samawa and Al-Rumitha. Total boron concentration values are fluctuated between 1.033 mg. kg\(^{-1}\) and 14.658 mg. kg\(^{-1}\) in all of the studied soils. The results showed too the total boron values are not conducted with the tourmaline mineral percent in all sites.

Keywords
Soil boron, Soil pedon, River slop, Boron reduction, Total boron.

Introduction
The most common boron form of its natural geological resources is boric acid, H\(_3\)BO\(_3\). In nature, it is bound to other material forming compounds named borates and borates ions B\(_2\)BO\(_3\)\(^{-3}\). In cultivated soils, boric acid is the most common, [1]. Salinity affected soils that have poor drain system is known for its high boron concentration. Source of boron in these soils is either of irrigation water or of underground water that actively contribute in increases soil salinity, which mostly enrich with different ions form of boron. Moreover, aggregate boron content in soil is depends also on the original materials, [2], [3]. Boron is existed in the dry and semi-dry soils and it is easy washable, [4]. Acidic soils, soils that boron have been washed of, carbonates minerals enrich soils, and sandy soils that lacked to organic matter are considered as boron poor soils, [5]. Its concentration increases on the surface layer in dry and semi-dry soils, [6].

Sedimentary rocks contain range of boron of (20-100) mg.kg\(^{-1}\). Its content in soils that derived of these rocks is fluctuated between (7-80) mg. kg\(^{-1}\). They have boron more than igneous rocks its derived soils (5-15) mg. kg\(^{-1}\). [7],[8] mentioned that sedimentary rocks of sea origin have 500 mg. kg\(^{-1}\) or more. Rocks content of boron is 5-10 mg. kg\(^{-1}\), and 4-5 mg. kg\(^{-1}\) its content in the oceans and seas, [9]. Soil boron has 4 forms that are: mineral boron, bound boron to organic matter, soluble boron in soil, and adsorbed boron. Boron that bound to mineral compounds is unavailable for plant absorption unless become soluble boron in soil solution, [10].

This study was conducted to find out the existence of boron in different layers of cultivated soils in central the Euphrates River in Iraq and the role of depthness and rivers
declivity on its concentration. A few studies have been conducted in this area of Iraq about boron forms and its level in calcareous soils.

Materials and Methods

Soil pedon were determined in cultivated farms close to the main Euphrates River and its branches (Hilla and Al-Daghara rivers) in provinces of Karbala, Babylon, Najaf, Diwaniyah, and Al-Muthana. 10 soil pedon were made in the mentioned provinces as followed: Soil pedon of adjacent area to the main Euphrates River were digged on counties of Twarije, Kufa, Gamas, and Al-Samawa, soil pedon of Missaib, Hashmiah, Diwaniyah, and Rumitha were done on farms that are close to the Hilla River, and soil pedon of Al-Daghara and Affak are belongs to the area of Al-Daghara River. Soil specimens were taken of each diagnostic pedon layer for laboratory examinations. Assessments of physical characteristics were done according to the following mentioned methods and their values are in the tables (1, 2, and 3). Soil particles volumes test was done by the pipette method to assess soil separators according to Day method, [11]. Buiik density was estimated by Core Sampler method, [11]. In the same way, chemical characteristics were estimated according to the following methods and their values are in the tables (4, 5, and 6). Electric connectivity in an extract soil to water (1:1) was measured by an Electrical Conductivity Bridge device, [12]. Power of hydrogen (pH) of an extract soil to water (1:1) was assessed by using pH-Meter device, [12]. Exchange capacity of positive ions were measured by ammonium acetate method 1.0 molar at (pH=7), [13]. Soil organic matter was estimated by using the method of wet digestion by titration it with ammonium ferrous sulphate according to Wikelly black methods, [12]. Gypsum was estimated by acetone sedimentation method, [14]. Carbone minerals were estimated by using Cacimeter device that based on calculation of Carbon dioxide that resulting of hydrochloric acid reaction 3N, which diluted with carbonates, [15]. Positive soluble ions of K⁺, Na⁺, Mg⁺, Ca²⁺ in extraction (1:1). Ca²⁺ and Mg²⁺ were estimated by the titration method by using Na₂EDTA, [16]. Using a flame photometer device, K⁺ and Na⁺ were assessed, [14]. Negative soluble ions, carbonate and bicarbonate were measured by titration with On the other hand, chloride measured by titration with of AgNO₃, [16]. Carbonates were measured by using method with BaCl₂, then using the Spectrophotometer device, [11]. Total boron was estimated using burning method according to [16] then using the dual electric induction device.

Weight ratio of heavy to light minerals in sand fraction

Two sites of Musayyib and Ramitha on the Euphrates River adjacent area (at the beginning and end of the section) were selected in order to study the presence of Tourmaline mineral and its effect on Boron abundance in soil. For the purpose of studying the ratios of heavy and light minerals and the diagnosis of Tourmaline percentage, soil samples were dismantled by hand with light hammering. Distilled water was then added and the soil samples disintegrated and dried. After drying, 15 g of each sample was taken washed on the 63 micron sieve in order to remove the clay and sludge and isolating sand separator for mineral analysis and mineral content calculation.

5 g of the sand fraction was taken to separate the heavy from the light minerals by the heavy liquid of Bromoform. After separation, heavy and light minerals were weighed and the percentage of each fraction is extracted, [17]. table (7).

After the light minerals were isolated, they were washed by acetone for cleaning and purifying to be easily diagnosed by the polarized microscope. After washing, minerals were spread on glass slides and bonded with adhesive sandblast. Minerals were examined and diagnosed under the microscope and the percentage of each mineral was recorded. They were digitally imaged by a digital camera and each image measured by drawing scale using force of magnification and a micro-ruler, [18]. The following table (8) and images (1-6) show the types of minerals that were diagnosed and the percentages of each mineral.
Results and discussion

Total soil boron of the main Euphrates River adjacent soils
Table (9) shows total boron concentrations of the farms soil that are adjacent to the main Euphrates river. Generally, there are a reduction in its concentration as going depth in soil body. The highest value of accumulation boron are at the first layer of depth on Al-Samawa location. The least value are at the third depth layer on Twarije. Their values ranged between (1.03 and 11.43) mg. kg\(^{-1}\). The results in table (9) refer to that soil contents of total boron content are varied from one location to another, and it are also varied within location pedon layer. This may attribute this variation to the differences in: soil factors, original soil, potential of hydrogen, clay percentage, nature of location effecting factors, and level of ground water. Boron concentration increases directly with when potential of hydrogen (pH) rise up, and drops when pH decreases. The existence of carbonates in the soil leads to lower boron availability, which are the same with the other micro elements, [20]. Samawa’s soil farms soil has distinguished comparing with other, since it has higher total boron content than other locations of the Euphrates river.

Total soil boron of the Hilla’s River adjacent soils
Table (10) presents accumulation boron concentrations values. Results show a drop in values of boron concentration with depth in soil. The highest total boron value are at the first depth level at Missaib county (2.10) mg.kg\(^{-1}\). The lowest value is at the third depth layer on Hashmiah county (12.91) mg.kg\(^{-1}\), [21]. This values is less than the ones that [22] found when studied some of sedimentary soils. Soil content of total boron is among and within location, which due to nature of soil origin, its content of clay and organic matter since clay minerals and cation exchange capacity effecting boron existence, [23].

Total soil boron of the Daghara’s River adjacent soils
Total boron concentration are presented in table (11). Results clearly show drop in boron concentration values with depth. The highest boron content value was recorded at the surface layer of depth at Al-daghara county (14.65) mg.kg\(^{-1}\). The least value was found at the fourth layer on Afak County (2.43) mg.kg\(^{-1}\). On Al-daghara location, the fourth layer had higher boron content than the upper one because it are ground water limits table (11). These Values are higher than the values that [9] refers to. Soil content of boron are changed according to: soil sort, soil texture, soil humidity, and its organic matter content, [21]. Carbonates minerals is affecting boron availability since they bound it, [24]. Total boron concentration is ranged between (1.03 – 12.91) mg. kg\(^{-1}\) for all of the studied soils. This study clarifies significant differences among and within locations.

Percentage of tourmaline mineral and its relation to total boron
Table (12) shows the percentages of tourmaline mineral of the Musayyib and al-Rumaitha soil sites. Results presents that tourmaline percentage was low in Musayyib site compared to Al-Rumaitha site. There values ranged from (1.0) to (1.4) %. The location of Rumaytha had a higher percentage of tourmaline than Musayyib, which ranged between (3.8 - 2.9). Higher Tourmaline percentage at Al-Rumaitha site is due to of the different source of wind sediments. The deposits of the Al-Rumaitha area in southwestern Iraq originate from Saudi mountains, which are made up of tourmaline-rich pyramids. During weathering, erosion and transport, tourmaline is transported through the southwestern valleys of Iraq. Thus, the proportion of tourmaline is high at Al-Rumaitha, [25]. Tourmaline is one of the most minerals that contain boron in the soil. It contains 10% of boron. This mineral is resistant to weathering. Boron forms in mineral compounds are not readily available for plant absorption unless they degrade and become soluble in soil solution, [10]. The results of
Table (12) show that the total values of boron were not consistent with the proportion of tourmaline as the increases or decreases. This shows that source of this element is not only of this mineral, but also other sources could provide it to the soil. Images (1-6) show the photos of tourmaline in Al-Rumaitha and Al-Musayyib sites. They show that this mineral was not subjected to extreme weathering since the edges of it smooth, which indicating the lack of boron contribution by this mineral to these soils. This may be due to the low severity of weathering factors because the study soils are located in dry and semi-arid soils, which reduces the contribution of the mineral in processing boron. Results indicate and confirm that the presence of tourmaline in the soil due to pollution not to the soil origin.

Table (1): Some of the physical characteristics of the soils of the main Euphrates River adjacent soils.

| Location          | Depth Cm | Soil Separators mg. kg⁻¹ | Soil texture   | Bulk Density Mg. m⁻³ |
|-------------------|----------|--------------------------|---------------|----------------------|
|                   |          | Silty | Loam | Clay |                  |                      |
| Twarije           | 0-32     | 220  | 420  | 360  | Clay loam         | 1.40                 |
|                   | 32-62    | 220  | 540  | 240  | Silty loam        | 1.38                 |
|                   | 62-86    | 290  | 540  | 260  | Loamy             | 1.42                 |
|                   | 86-120   | 310  | 440  | 250  | Loamy             | 1.43                 |
| Kufa              | 0-31     | 210  | 440  | 350  | Clay loam         | 1.39                 |
|                   | 31-60    | 180  | 370  | 450  | Silty clay loam   | 1.42                 |
|                   | 60-120   | 270  | 450  | 280  | Loamy             | 1.42                 |
| Gamas             | 0-49     | 240  | 510  | 250  | Silty loam        | 1.38                 |
|                   | 49-90    | 240  | 385  | 375  | Clay loam         | 1.42                 |
|                   | 90-115   | 320  | 430  | 250  | Loamy             | 1.43                 |
| Al-Samawa         | 0-33     | 190  | 340  | 470  | Clay              | 1.39                 |
|                   | 33-58    | 160  | 415  | 425  | Silty clay        | 1.38                 |
|                   | 58-99    | 215  | 430  | 355  | Clay loam         | 1.41                 |
|                   | 99-120   | 225  | 405  | 370  | Clay loam         | 1.42                 |
### Table (2): Some of the physical characteristics of the soils that are adjacent to the Hila River.

| Location      | Depth cm | Soil Separators mg. kg$^{-1}$ | Soil texture   | Buik Density Mg. m$^3$ |
|---------------|----------|--------------------------------|-----------------|-------------------------|
|               |          | Silty | Loam | Clay |               |                      |
| Missaib       | 0-39     | 250   | 300  | 450  | Clay          | 1.41                |
|               | 39-64    | 165   | 410  | 425  | Silty clay    | 1.40                |
|               | 64-98    | 165   | 440  | 395  | Silty clay loam | 1.40              |
|               | 98-125   | 166   | 450  | 384  | Silty clay loam | 1.41              |
| Hashmiah      | 0-34     | 280   | 460  | 260  | Loamy         | 1.40                |
|               | 34-62    | 205   | 440  | 355  | Silty loam    | 1.42                |
|               | 62-115   | 300   | 470  | 230  | Loamy         | 1.43                |
| Diwaniyah     | 0-35     | 166   | 441  | 393  | Silty clay loam | 1.39              |
|               | 35-69    | 168   | 460  | 372  | Silty clay loam | 1.40              |
|               | 69-130   | 220   | 410  | 370  | Clay loam     | 1.42                |
| Rumitha       | 0-49     | 190   | 405  | 405  | Silty clay    | 1.38                |
|               | 49-72    | 170   | 410  | 420  | Silty clay    | 1.39                |
|               | 72-100   | 170   | 445  | 385  | Silty clay loam | 1.40              |

### Table (3): Some of the physical characteristics of the soils that are adjacent to the Al-Daghara River.

| Location     | Depth cm | Soil Separators mg. kg$^{-1}$ | Soil texture   | Buik Density Mg. m$^3$ |
|--------------|----------|--------------------------------|-----------------|-------------------------|
|              |          | Silty | Loam | Clay |               |                      |
| Al-Daghara   | 0-24     | 210   | 360  | 425  | Clay          | 1.39                |
|              | 24-54    | 175   | 415  | 410  | Silty clay    | 1.40                |
|              | 54-85    | 180   | 400  | 420  | Silty clay    | 1.41                |
|              | 85-110   | 165   | 440  | 395  | Silty clay loam | 1.41              |
| Affak        | 0-21     | 220   | 520  | 260  | Silty loam    | 1.38                |
|              | 21-47    | 210   | 380  | 410  | Clay loam     | 1.42                |
|              | 47-76    | 230   | 375  | 395  | Clay loam     | 1.43                |
|              | 76-110   | 195   | 435  | 370  | Silty clay loam | 1.42              |
Table (4): Some of the chemical characteristics of the soils that are adjacent to the main Euphrates River.

| Location       | Depth Cm | EC ds.m⁻¹ | pH | C molc. kg⁻¹ | CEC ds.m⁻¹ | Carbonates minerals | O.M | Gypsum Gm.kg⁻¹ |
|----------------|----------|-----------|----|--------------|------------|---------------------|-----|----------------|
| Twartije       |          |           |    |              |            |                     |     |                |
| 1              | 0-32     | 4.50      | 7.78 | 1.40         | 0.93       | 2.46                | 0.60 | 1.70           | 0.53 | Nill           | 27.83 | 239      | 11.61 | 4.16 |
|                | 32-62    | 2.99      | 7.71 | 0.9           | 0.65       | 1.65                | 0.032 | 0.42           | 0.99 | Nill           | 33.12 | 221      | 9.20  | 4.38 |
|                | 62-86    | 3.49      | 7.80 | 0.92         | 0.91       | 1.94                | 0.029 | 0.48           | 1.10 | Nill           | 23.36 | 235      | 7.41  | 1.13 |
| 4              |          |           |    |              |            |                     |     |                |
| Kufa           |          |           |    |              |            |                     |     |                |
| 5              | 0-31     | 1.808     | 7.60 | 0.53         | 0.45       | 1.02                | 0.023 | 0.25           | 0.63 | 0.16         | Nill   | 30.35    | 271   | 10.89 | 0.51 |
|                | 31-60    | 3.506     | 7.68 | 0.94         | 0.94       | 1.96                | 0.026 | 0.28           | 1.09 | 0.31         | Nill   | 32.78    | 293   | 8.71  | 0.69 |
|                | 60-120   | 2.06      | 7.59 | 0.67         | 0.43       | 1.05                | 0.024 | 0.26           | 0.8  | 0.15         | Nill   | 24.00     | 278   | 6.53  | 0.34 |
| 8              |          |           |    |              |            |                     |     |                |
| Gamas          |          |           |    |              |            |                     |     |                |
| 9              | 0-49     | 2.224     | 7.80 | 0.87         | 0.82       | 1.79                | 0.020 | 0.38           | 1.22 | 0.27         | Nill   | 33.54    | 255   | 11.23 | 0.90 |
|                | 49-90    | 3.154     | 7.72 | 0.84         | 0.78       | 1.75                | 0.062 | 0.37           | 1.20 | 0.26         | Nill   | 30.06    | 286   | 8.37  | 0.49 |
|                | 90-115   | 2.46      | 7.85 | 0.78         | 0.53       | 1.26                | 0.031 | 0.29           | 0.89 | 0.20         | Nill   | 23.81    | 269   | 7.15  | 0.81 |
| 10             |          |           |    |              |            |                     |     |                |
| Al-            |          |           |    |              |            |                     |     |                |
| Samawa         | 0-33     | 2.57      | 7.65 | 0.82         | 0.56       | 1.63                | 0.030 | 0.40           | 0.97 | 0.22         | Nill   | 41.31    | 292   | 15.30 | 3.43 |
|                | 33-58    | 4.00      | 7.59 | 1.38         | 0.87       | 2.13                | 0.035 | 0.58           | 1.37 | 0.34         | Nill   | 37.53    | 262   | 12.08 | 2.81 |
|                | 58-99    | 3.20      | 7.63 | 0.91         | 0.89       | 1.76                | 0.017 | 0.37           | 1.20 | 0.26         | Nill   | 33.19    | 230   | 9.18  | 2.23 |
|                | 99-120   | 2.05      | 7.60 | 1.24         | 0.92       | 2.38                | 0.029 | 0.53           | 1.50 | 0.34         | Nill   | 34.40    | 246   | 7.30  | 0.87 |
Table (5): Some of the Chemical characteristics of the soils that are adjacent to the Hila River.

| Location | Depth Cm | EC ds.m$^{-1}$ | pH | C molc. kg$^{-1}$ | Ca$^{2+}$ | Mg$^{2+}$ | Na$^{+}$ | K$^{+}$ | SO$_4^{2-}$ | Cl$^{-}$ | HCO$_3^{-}$ | CO$_3^{2-}$ | CEC ds.m$^{-1}$ |
|-----------|----------|----------------|----|------------------|-----------|-----------|---------|-------|-------------|--------|------------|-----------|----------------|
| 1 Missaib | 0-39     | 14.22          | 7.68 | 4.23         | 3.92     | 7.55     | 0.046   | 1.88  | 4.98       | 1.34   | 39.58      | 336       | 13.84         | 2.50         |
| 2 Missaib | 39-64    | 5.10           | 7.72 | 1.54         | 1.23     | 2.70     | 0.04    | 0.64  | 1.84       | 0.46   | 36.36      | 281       | 10.22         | 2.79         |
| 3 Missaib | 64-98    | 4.60           | 7.79 | 1.44         | 1.09     | 2.53     | 0.033   | 0.60  | 1.71       | 0.38   | 34.25      | 289       | 8.30          | 1.34         |
| 4 Missaib | 98-125   | 4.36           | 7.70 | 1.35         | 1        | 2.36     | 0.033   | 0.27  | 1.66       | 0.51   | 34.88      | 252       | 7.14          | 0.75         |
| 5 Hashmiah| 0-34     | 7.40           | 7.63 | 2.03         | 1.70     | 4.13     | 0.032   | 1.05  | 2.66       | 0.63   | 21.36      | 270       | 9.78          | 1.69         |
| 6 Hashmiah| 34-62    | 10.74          | 7.69 | 3.22         | 2.82     | 5.86     | 0.039   | 1.43  | 4.03       | 0.87   | 23.00      | 278       | 6.29          | 2.38         |
| 7 Hashmiah| 62-115   | 1.832          | 7.61 | 0.59         | 0.39     | 0.88     | 0.022   | 0.22  | 0.69       | 0.14   | 22.18      | 246       | 6.00          | 1.08         |
| 8 Diwaniyah| 0-35    | 5.19           | 7.38 | 1.55         | 1.20     | 2.83     | 0.034   | 0.65  | 1.89       | 0.42   | 33.65      | 294       | 12.73         | 0.76         |
| 9 Diwaniyah| 35-69   | 8.18           | 7.46 | 2.41         | 2.14     | 4.66     | 0.045   | 1.10  | 3.30       | 0.16   | 34.12      | 132       | 8.25          | 0.85         |
| 10 Diwaniyah| 69-130 | 6.62           | 7.42 | 2.32         | 1.46     | 3.63     | 0.032   | 0.97  | 2.41       | 0.52   | 31.65      | 240       | 7.12          | 0.46         |
| 11 Rumitha | 0-49    | 3.69           | 7.55 | 1.22         | 0.87     | 2.38     | 0.026   | 0.53  | 1.54       | 0.32   | 36.28      | 278       | 14.12         | 0.28         |
| 12 Rumitha | 49-72   | 3.32           | 7.51 | 0.91         | 0.85     | 1.78     | 0.02    | 0.38  | 1.22       | 0.28   | 37.40      | 246       | 11.45         | 0.56         |
| 13 Rumitha | 72-100  | 4.14           | 7.63 | 1.26         | 0.94     | 2.40     | 0.024   | 0.54  | 1.56       | 0.33   | 33.74      | 228       | 8.26          | 0.24         |
Table (6): Some of the chemical characteristics of the soils that are adjacent to the Al-Daghara River.

| Location  | Depth (cm) | EC ds.m⁻¹ | pH | Ca⁺² | Mg⁺² | Na⁺² | K⁺¹ | SO₄²⁻ | Cl⁻ | HCO₃⁻ | CO₃⁻¹ | Carbonates | O.M | Gypsum |
|-----------|------------|-----------|----|------|------|------|-----|--------|-----|--------|--------|------------|-----|--------|
| Al-Daghara| 0-24       | 2.10      | 7.56 | 0.69 | 0.48 | 1.04 | 0.027 | 0.26 | 0.80 | 0.15 | Nill | 38.69 | 235 | 14.65 |
| Al-Daghara| 24-54      | 4.14      | 7.51 | 1.30 | 0.99 | 2.46 | 0.025 | 0.55 | 1.57 | 0.34 | Nill | 35.17 | 289 | 9.82 |
|            | 54-85      | 3.68      | 7.60 | 0.99 | 0.91 | 2.03 | 0.31 | 0.44 | 1.32 | 0.32 | Nill | 36.26 | 294 | 8.59 |
|            | 85-110     | 3.20      | 7.58 | 0.89 | 0.80 | 1.7  | 0.032 | 0.37 | 2.07 | 0.53 | Nill | 32.18 | 250 | 7.29 |
| Affak      | 0-21       | 6.48      | 7.81 | 2.18 | 1.36 | 3.62 | 0.028 | 0.93 | 2.32 | 0.51 | Nill | 22.30 | 285 | 10.33 |
|            | 21-47      | 6.66      | 8.03 | 2.25 | 1.4  | 3.74 | 0.036 | 0.95 | 2.34 | 0.55 | Nill | 29.06 | 261 | 9.29 |
|            | 47-76      | 5.56      | 7.88 | 1.71 | 1.31 | 3.22 | 0.026 | 0.70 | 2.07 | 0.52 | Nill | 27.85 | 279 | 8.10 |
|            | 76-110     | 4.12      | 7.83 | 1.23 | 0.91 | 2.38 | 0.025 | 0.53 | 1.57 | 0.35 | Nill | 30.18 | 257 | 6.23 |

Table (7): Percentage of heavy and light minerals for Al-Rumaitha and Al-Masib
(Estimated in the laboratories of the College of Science, University of Baghdad)

| Location | Depth (cm) | Sample Weight (g) | Light Minerals Weight (g) | Light Minerals % | Heavy Minerals Weight (g) | Heavy Minerals % |
|----------|------------|-------------------|--------------------------|-----------------|--------------------------|-----------------|
| Rumaitha | 49 – 0     | 5                 | 4.82                     | 96.4            | 0.18                     | 3.6             |
|          | 49-72      | 5                 | 4.84                     | 96.8            | 0.16                     | 3.2             |
|          | 72-100     | 5                 | 4.86                     | 97.2            | 0.14                     | 2.8             |
| Musayyib | 39 – 0     | 5                 | 4.88                     | 97.6            | 0.12                     | 2.4             |
|          | 64 – 39    | 5                 | 4.85                     | 97              | 0.15                     | 3               |
|          | 98 – 64    | 5                 | 4.83                     | 96              | 0.17                     | 3.4             |
Table (8) Mineral composition and percentage of tourmaline mineral for sand minerals at Musayyib and Rumaytha sites
(Estimated at the laboratories of the College of Science, University of Baghdad)

| Light Minerals and Components | Levels Depth |
|-------------------------------|--------------|
|                               | Rumaitha     | Musayyib    |
|                               | 0-49 | 49-72 | 72-100 | 0-39 | 39-64 | 64-98 |
| Monocrystalline Quartz        | 30.5 | 30.3 | 31.5 | 30.5 | 31.4 | 30.3 |
| Polycrystalline Quartz        | 3.1  | 2.4  | 2.2  | 2.7  | 3.4  | 2.2  |
| Alkali Feldspar (Orthoclase)  | 1.2  | 1.5  | 1.3  | 1.5  | 1.3  | 1.5  |
| Alkali Feldspar (Microcline)  | 1.1  | 1.3  | 1.4  | 1.1  | 1.4  | 1.8  |
| Plagioclase Feldspar          | 1.4  | 1.3  | 1.5  | 1.9  | 1.5  | 1.6  |
| Carbonate Rock Fragments      | 32.4 | 32.4 | 33.3 | 28.7 | 32.4 | 33.7 |
| Chert Rock Fragments          | 15.7 | 14.1 | 14.9 | 13.3 | 16.2 | 11.5 |
| Igneous Rock Fragments        | 1.2  | 1.5  | 1.6  | 1.2  | 1.3  | 1.8  |
| Metamorphic Rock Fragments    | 1.2  | 1.2  | 1.8  | 1.6  | 1.2  | 1.7  |
| Mudstone Rock Fragments       | 5.2  | 5.3  | 5.6  | 5.0  | 5.1  | 4.7  |
| Evaporates                    | 3.1  | 3.7  | 3.7  | 3.9  | 3.9  | 3.3  |
| Others                        | 1.0  | 1.7  | 2.5  | 1.5  | 1.8  | 1.3  |

| Heavy Minerals                | Levels Depth |
|-------------------------------|--------------|
|                               | 0-49 | 49-72 | 72-100 | 0-39 | 39-64 | 64-98 |
| Opaques (Iron Oxides)         | 36.4 | 46.0 | 46.4 | 44.1 | 44.2 | 48.5 |
| Chlorite                      | 5.2  | 5.8  | 5.6  | 5.8  | 4.7  | 5.2  |
| Rutile                        | 3.8  | 5.7  | 4.0  | 5.0  | 5.3  | 5.9  |
| Zircon                        | 6.2  | 6.9  | 9.9  | 8.7  | 9.9  | 8.2  |
| Pyroxene                      | 7.5  | 6.2  | 5.3  | 4.5  | 4.9  | 4.7  |
| Amphibole                     | 7.5  | 7.9  | 4.8  | 4.4  | 4.7  | 5.2  |
| Biotite                       | 4.4  | 4.4  | 3.5  | 3.6  | 3.6  | 4.6  |
| Muscovite                     | 7.5  | 7.8  | 8.7  | 7.9  | 7.9  | 8.5  |
| Tourmaline                    | 3.8  | 2.9  | 3.2  | 1.2  | 1.4  | 1.0  |
| Epidote                       | 5.9  | 5.7  | 5.8  | 6.8  | 5.9  | 5.8  |
| Garnet                        | 4.4  | 4.7  | 4.7  | 3.7  | 3.5  | 4.6  |
| Kyanite                       | 1.1  | 1.1  | 1.7  | 2.1  | 2.1  | 2.1  |
| Others                        | 1.0  | 2.1  | 1.1  | 1.3  | 2.2  | 1.3  |
### Table (9): Total boron values of the soils that are adjacent to the main Euphrates River.

| Location     | Depth  | Total boron mg.kg⁻¹ |  
|--------------|--------|---------------------|
| Twarije      | 0-32   | 4.451               |
|              | 32-62  | 3.163               |
|              | 62-86  | 1.033               |
|              | 86-120 | 1.367               |
| Kufa         | 0-31   | 2.352               |
|              | 31-60  | 2.771               |
|              | 60-120 | 1.146               |
| Gamas        | 0-49   | 4.811               |
|              | 49-90  | 2.306               |
|              | 90-115 | 1.250               |
| Al-Samawa    | 0-33   | 11.432              |
|              | 33-58  | 6.903               |
|              | 58-99  | 3.365               |
|              | 99-120 | 3.177               |

LSD values: Location = 0.0005*, Depth = 0.0002*, Location and depth interaction =0.0008*

### Table (10): Total boron values of the soils that are adjacent to the Hilla River.

| Location   | Depth  | Total boron mg.kg⁻¹ |  
|------------|--------|---------------------|
| Missaib    | 0-39   | 12.912              |
|            | 39-64  | 10.536              |
|            | 64-98  | 2.325               |
|            | 98-125 | 2.869               |
| Hashmiah   | 0-34   | 5.752               |
|            | 34-62  | 3.230               |
|            | 62-115 | 2.106               |
| Diwaniyah  | 0-35   | 8.768               |
|            | 35-69  | 3.145               |
|            | 69-130 | 3.420               |
| Rumitha    | 0-49   | 9.688               |
|            | 49-72  | 10.423              |
|            | 72-100 | 7.316               |

LSD values: Location = 0.0004*, Depth = 0.0001*, Location and depth interaction =0.0006*
Table (11): Total boron values of the soils that are adjacent to the Al-Daghara River.

| Location | Depth Cm | Total boron mg.kg⁻¹ |
|----------|----------|---------------------|
| 1 Al-Daghara | 0-24 | 14.658 |
| 2 | 24-54 | 9.543 |
| 3 | 54-85 | 5.661 |
| 4 | 85-110 | 6.374 |
| 5 Affak | 0-21 | 7.633 |
| 6 | 21-47 | 4.748 |
| 7 | 47-76 | 3.912 |
| 8 | 76-110 | 2.430 |

LSD values: Location = 0.0004*, Depth = 0.0001*, Location and depth interaction = 0.0005*

Table (12): Percentage of tourmaline and total boron values in the levels of Musayyib and Rumaytha soils.

| Location | Depth Cm | Tourmaline % | Total Boron mg.kg⁻¹ |
|----------|----------|--------------|---------------------|
| Musayyib | 0 – 39 | 1.2 | 12.912 |
| | 39 – 64 | 1.4 | 10.536 |
| | 64 – 98 | 1.0 | 2.325 |
| Rumaytha | 0 – 49 | 3.8 | 9.688 |
| | 49-72 | 2.9 | 10.423 |
| | 72-100 | 3.2 | 7.316 |
image (1) tourmaline mineral for the first horizon (Rumaitha location)
Honey color, pleochroic, prismatic form tourmaline, sample number R1, PPL.
image (2) tourmaline mineral for the second horizon (Rumaitha location)
Pleochroic light brown color tourmaline, sample number R2, PPL.
Pleochroic light brown color tourmaline, sample number R3, PPL.
image (4) tourmaline mineral for the first horizon (Musayyib location)
Pleochroic light brown color tourmaline, sample number M1, PPL.
image (5) tourmaline mineral for the second horizon( Musayyib location)
Honey pleochroic color tourmaline,  sample number M2, PPL.
Pleochroic light brown color tourmaline, sample number M3, PPL.

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دور الانحدار والعمق في تركيز البئرون الكلي في ترب بعض محافظات العراق

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الخلاصة

البحث مستل من رسالة ماجستير للباحث الثاني

الكلمات المفتاحية: بئرون التربة، بئرون البحيرة، انحدار النهر، احتلال البئرون، اجمالي البئرون.