Mineralogy of Sand Fraction in Selective Soil Sections in Baghdad City

Dunya A AL-jibury¹, Luma Abdalalah Sagban Alabadi², Hasan Kattoof Jasim³

¹Department of Council Affairs / Presidency of the University of Baghdad.
²Department of Horticulture and Garden Engineering/College of Agriculture/ University of Al-Qadisiyah.
³Department of Geology / College of Science / University of Baghdad.

Email : dunya.aaaa@gmail.com

Abstract. This study has been undertaken to investigate the mineralogical properties and morphological features of sand fraction in some soils of Baghdad / Iraq. The morphological features of sand fractions were studied by Polarized optical microscope. Results have shown that the grains of these minerals from samples of sands have different colors, those from the surface horizons have dark brownish spots, due to staining by organic matter, and have a yellowish–to yellowish brown spots due to accumulation of Iron oxides. Results of light minerals indicated that quartz is dominant due to effect of parent material of these soils. Two types of opaque minerals (black and brown) are found, whereas the brown opaque minerals were obvious in heavy minerals. Three groups of transparent heavy minerals are found, stable minerals (Pyroxen and Amphibole), metastable minerals (Epidote and Garnet), and Ultra stable minerals (Zircon and Tourmaline).

Keyword: Mineralogical Properties of Sand, Baghdad, Iraq, Heavy Minerals, Light Minerals, Polarized optical microscope.

Introduction

Baghdad, the capital city of Iraq, located on Tigris River between latitudes 33.25 – 33.14°N and longitudes 44.31 – 44.17 °E.

Climate

The climate of Iraq is characterized by hot–dry summers and cold–rainy winters. Roughly 90% of the annual rainfall occurs between November and April, most of it in the winter months from December through March. The remaining 6 months (from May to October), particularly the hottest ones, are June, July, and August where the rain has not fallen. The average temperature in Iraq ranges from higher than 48°C (120°F) in July and August.

Of course, there is considerable difference in temperature between day and night. The day is hot, whereas the night is colder. Generally, the climate of Mesopotamia is semi-arid with a maximum temperature of up to 53°C in July–August and a minimum temperature of −7°C in January. The prevailing wind is generally NW and is dry for about 300 days of the year, turning to SE and humid for about 60 days (Jassim and Goff 2006).
Methods of Study:
Baghdad City, the capital city of Iraq, is situated in the central part of Iraq as shown in Fig (1).
The study area includes two parts:
1. The highways of Mohammed AL-Qasim, Al-Dura, and AL-Tagiyat, the highways are connected with each other to making a circle around to Baghdad City.
2. The interior streets and squares of Baghdad city center.
The study area is semi arid to arid climate.

2.2. Sampling description and collection:
14 Samples of sands were collected from the studied area from (0 – 25) cm of the topsoil. The sand fractions were separated into light and heavy minerals using the standard bromoform method. The mineral composition of both light and heavy minerals was determined by using the standard counting technique by using the polarizing microscope.

Sand samples was separated and air-dried, and was weighed for purpose of separating the heavy metals from light in Samples by Separating funnel Using Bromoform (CHBr3) of a specific weight 2.89. Sand fractions were studied by Polarized optical microscope according to Carver, 1971. The whole mineralogy of the samples is determined in Lab in the Geology Department / University of Baghdad.

Result and Analysis:

Mineralogy
Mineralogy of the sediments offers reliable inputs on the provenance and subsequent history. Heavy minerals though present in small quantity are resistant to weathering and abrasion and therefore represent the parent lithology even after many cycles of erosion and deposition. Lighter minerals have this potential to a limited extent. Quartz being the most important (Saini, 2003). The 2-4 phi fraction of the 15 samples are treated with 10% HCL, washed and dried, then 5 grams of each sample was gravity settled in bromoform. Light and heavy fractions were separated. The heavy minerals were weighed to obtain the weight percent. Both fractions were mounted on petrographic slides and were examined and counted using the petrographic microscope.

Light Minerals
The light mineral fraction of Baghdad samples comprise more than (97.9%) of the total mineralogy, with an average of 45.4 % quartz (including chert fragments), 4.3% feldspar, 23.6% carbonates, 2.5% igneous, and metamorphic rock fragments, 15.8% evaporites, and 6.3% clay coated grains (Table.1).
Table 1: Percentages and average of the light fraction in the studied samples.

| Components                    | Light Components | Samples Number | Average |
|-------------------------------|------------------|----------------|---------|
|                               |                  | 1  | 5  | 10 | 14 | 18 | 22 | 27 | 31 | 36 | 40 | 44 | 51 | 56 | 69 |
| Quartz                        |                  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Monocrystalline Quartz        | 30.4             | 35.4| 32.1| 34.8| 38.8| 34.7| 33.2| 32.1| 31.7| 32.3| 32.3| 34.1| 36.2| 23.5| 35.7| 32.5|
| Polycrystalline Quartz        | 1.9              | 1.8 | 4.2 | 2.3 | 2.6 | 2.4 | 2.8 | 3.2 | 2.4 | 2.3 | 1.8 | 2.8 | 2.3 | 2.7 | 2.5 |
| Feldspar                      |                  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Orthoclase                    | 0.8              | 2.0 | 2.2 | 1.5 | 1.6 | 1.8 | 1.8 | 2.2 | 1.6 | 1.8 | 2.0 | 1.8 | 1.5 | 1.8 | 1.7 |
| Microcline                    | 0.6              | 0.8 | 1.6 | 1.2 | 1.2 | 1.2 | 1.6 | 1.2 | 1.2 | 1.6 | 1.6 | 1.2 | 1.2 | 1.2 | 1.6 |
| Plagioclase                   | 1.1              | 1.8 | 1.2 | 1.7 | 1.7 | 1.5 | 1.6 | 1.2 | 1.5 | 1.3 | 1.1 | 1.6 | 1.1 | 1.3 | 1.4 |
| Evaporites                    | 15.7             | 12.6| 13.5| 11.7| 9.4 | 10.4| 11.5| 10.5| 9.4 | 30.7| 24.6| 9.5 | 40.7| 10.7| 15.8|
| Carbonate Rock Fragments      | 24.9             | 23.1| 24.8| 26.7| 25.2| 23.3| 26.9| 24.8| 24.2| 13.3| 30.1| 25.9| 10.7| 26.3| 23.6|
| Chert Rock Fragments          | 14.4             | 12.6| 9.5 | 8.9 | 9.0 | 11.9| 10.5| 13.5| 16.7| 6.5 | 6.6 | 10.5| 6.9 | 8.5 | 10.4|
| Rock Fragments                |                  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Igneous Rock Fragments        | 0.9              | 1.0 | 1.4 | 1.7 | 1.3 | 1.6 | 1.6 | 1.4 | 1.3 | 1.2 | 1.0 | 1.6 | 1.1 | 1.3 | 1.3 |
| Metamorphic Rock Fragments    | 0.6              | 0.9 | 0.8 | 1.5 | 1.4 | 1.5 | 1.4 | 0.8 | 1.4 | 1.0 | 0.9 | 1.4 | 1.3 | 1.4 | 1.2 |
| Mudstone Rock Fragments       | 4.5              | 4.9 | 3.5 | 3.8 | 4.8 | 3.8 | 3.2 | 4.5 | 3.8 | 3.5 | 4.9 | 3.2 | 2.8 | 4.5 | 4.0 |
| Coated Grain by Clay          | 1.7              | 1.0 | 2.7 | 1.9 | 2.3 | 2.8 | 2.5 | 2.7 | 2.6 | 2.5 | 2.5 | 2.9 | 2.4 | 2.3 |     |
| Others                        | 2.4              | 1.1 | 2.5 | 2.3 | 1.9 | 2.5 | 1.8 | 1.5 | 2.2 | 2.0 | 1.1 | 1.8 | 2.0 | 1.8 | 1.9 |
Figure 2. Images of the light minerals in the studied samples. Whereby A: Alkali Feldspar (Microcline), B: C; Carbonate Rock Fragment, D: Evaporite Fragment (Gypsum), E: Plagioclase feldspar, F: Igneous rock fragment, G; Monocrytalline Quartz, H: Polycrytalline Quartz, I: Chert rock fragment.

Heavy Minerals
The heavy mineral residue of the studied samples is composed of opaque minerals as a main component 44.8% and non-opaque minerals.

The non-opaque mineral assemblage is mainly composed of chlorite 9.1%, mica (muscovite and biotite) 12.7%, amphiboles 5.6%, pyroxenes 5.5%, epidote 5.2%, zircon 5.1%, garnet 4.2%, and rutile 1.6%, staurolite 1.6%, kyanite 1.4%, tourmaline 1.3% arranged in a decreasing order of their average content (Table 2).

Table 2: Percentages and average of the heavy minerals in the studied samples.

| Heavy Minerals     | Samples Number | Average |
|--------------------|----------------|---------|
|                    | 1  | 5  | 10 | 14 | 18 | 22 | 27 | 31 | 36 | 40 | 44 | 51 | 56 | 69 |
| Opas (Iron Oxides) | 44.3 | 39.4 | 48.6 | 47.2 | 43.4 | 43.8 | 45.2 | 48.6 | 44.4 | 44.2 | 43.2 | 44.7 | 46.2 | 43.8 | 44.8 |
| Chlorite           | 8.5  | 9.6  | 7.6  | 8.9  | 10.2 | 9.2  | 9.8  | 9.5  | 9.6  | 8.0  | 8.8  | 9.2  | 9.2  | 9.1  |
| Zircon            | 6.7  | 6.4  | 5.6  | 5.5  | 5.4  | 4.3  | 4.3  | 4.3  | 4.3  | 5.2  | 5.7  | 5.3  | 4.5  | 4.3  | 5.1  |
| Garnet            | 5.7  | 4.9  | 2.8  | 3.3  | 4.1  | 4.7  | 3.1  | 2.8  | 3.5  | 4.8  | 4.5  | 5.1  | 5.3  | 4.7  | 4.2  |
| Epidote           | 4.2  | 5.5  | 5.4  | 4.8  | 4.3  | 5.0  | 5.1  | 5.6  | 5.3  | 5.0  | 5.8  | 6.8  | 4.8  | 5.0  | 5.2  |
| Pyroxene          | 6.2  | 6.3  | 4.5  | 6.2  | 6.8  | 5.4  | 5.5  | 4.5  | 4.8  | 6.2  | 4.3  | 5.5  | 5.2  | 5.4  | 5.5  |
| Amphibole         | 5.6  | 6.0  | 4.2  | 6.0  | 6.6  | 5.9  | 5.8  | 4.5  | 5.6  | 5.7  | 5.5  | 5.8  | 5.0  | 5.9  | 5.6  |
| Biotite           | 6.7  | 6.9  | 5.3  | 5.2  | 6.0  | 5.5  | 6.0  | 5.8  | 5.9  | 4.7  | 5.7  | 5.0  | 5.2  | 5.5  | 5.7  |
| Muscovite         | 7.8  | 7.8  | 7.5  | 5.9  | 6.5  | 6.8  | 6.5  | 7.5  | 7.2  | 6.3  | 7.8  | 6.7  | 6.9  | 6.8  | 7.0  |
The minerals grains vary in shape from prismatic to spherical and are mainly subrounded to rounded (Fig. 2).

**Table:**

| Mineral       | 0.6 | 1.2 | 1.0 | 1.8 | 1.2 | 1.8 | 1.5 | 1.4 | 1.1 | 1.0 | 1.8 | 1.3 |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Tourmaline    | -   | 0.6 | 1.2 | 1.0 | 1.8 | 1.2 | 1.8 | 1.5 | 1.4 | 1.1 | 1.0 | 1.8 |
| Rutile        | 0.7 | 1.4 | 1.1 | 1.2 | 1.7 | 1.2 | 1.3 | 1.9 | 1.3 | 2.4 | 1.4 | 1.2 |
| Staurolite    | 0.9 | 1.2 | 2.0 | 1.1 | 0.8 | 1.3 | 2.8 | 2.2 | 1.8 | 1.7 | 2.5 | 1.0 |
| Kyanite       | -   | 1.2 | 1.8 | 1.0 | 1.8 | 1.4 | 1.6 | 0.8 | 1.5 | 1.4 | 1.2 | 1.5 |
| Others        | 2.7 | 2.8 | 2.4 | 2.7 | 2.4 | 2.2 | 2.4 | 2.1 | 2.5 | 2.4 | 2.0 | 1.3 |

**Figure 3:** Images of heavy mineral in the studied samples of the studied area where by A; Chlorite, B; Biotite, C; Staurolite, D; Amphibole, E; Pyroxene, F; Garnet, G; Epidote, H; Zircon, I; Biotite, J; Opaques (Iron Oxides).
Conclusion:
The grains of these minerals from the sample of sand different colors, those of the surface horizons have brown spots, because of staining organic materials, and have brown spots yellow to yellow because of the accumulation of iron oxides.
And that quartz metal is dominant because of the effect of the mother material on this soil. Two types of dark metals (Black and Amphibole) were found. With three sets of transparent heavy metals, stable metals (Pyroxene and Amphibole), metastable minerals (Epidote and Garnet), super-mineral stability (Zircon and Tpurmaline).

References
[1] Al-Rajhy, C. 2006. Social life in Baghdad from the beginning of the sixteenth century until the fall of Baghdad in 1258 AD. Makkah: Umm Al-Qura University.
[2] Abdel-Ghaphor, E.S.A. (1982). Pedological studies of diagnostic horizons of some soils of Egypt. Ph.D. Thesis, Fac. of Agric., Al-Azhar Univ., Egypt.
[3] ang, Sh., Z. Wang, Y. Guo, C. Li and J. Cai, 2009. Heavy mineral compositions of the Changjiang (Yangtze River) sediments and their provenance-tracing implication. J. Asian Earth Sci., 35: 56-65.
[4] Garzanti, E. and S. Andoo, 2007. Heavy mineral concentration in modern sands: implications for provenance interpretation. In: Developments in Sedimentology, 58: 517-545.
[5] Dill, H. D., 1998, A review of heavy minerals in classic sediments with case studies from the alluvial fan through to the near shore marine environment. Earth. Sci. Rev, V. 45, P. 103-132.
[6] Garzanti, E., S. Ando and G. Vezzoli, 2008. Settling equivalence of detrital minerals and grain-size dependence of sediment composition. Earth Planet. Sci. Lett., 273: 138-151.
[7] Heroy, D.C., S.A. Kuehl, Jr. S.L. Good bred, 2003. Mineralogy of the Ganges and Brahmaputra Rivers: implications for river switching and late quaternary climate change. Sedi. Geolo., 155: 343-359.
[8] Hesse, P.R. 1971. A text Book of Soil Chemical Analysis. John Murray. LTD. London, British.
[9] Hou, B. and Frakes L.A. 2004. Tertiary sea levels and heavy mineral deposition in the eastern eucla basin, SA, Roach L.C. ed. Regolitir. CRC LEME, pp.140-143.
[10] Jassim SZ, Goff JC (eds) (2006) Geology of Iraq, 1st edn. Dolin, Prague and Moravian Museum, Brno, Czech Republic.
[11] Milner, H.B., 1962. Sedimentology petrography. II& I. George Allen & Unwin, LTD. London.
[12] Page, A.L., R.H. Miller, and D.R. Kenney. 1982. Methods of Soil Analysis Part (2). 2nd ed. Agronomy 9Am. Soc. Agron. Madison, Wisconsin.
[13] Papanicolaou, E.P.1976. Determination of cation exchange capacity of calcareous soils and their percent base saturation. Soil Sci. 121:65-71.
[14] Saini, H.S., (2003). Sedimentological Characters of the Late Quaternary Aeolian Sediments of Haryana. Proc. Indian Nat. Sci. Acad. 69, A, no. 2, pp. 201-215.
[15] Sillanpaa, M. (1972). Trace elements in soils and agriculture. FAO Soils bull. 17, Rome, Italy.
[16] Walkley, A. and I. A. Black. 1934. An examination of the Degtjareff method for determining soil organic matter & a proposed modification of the chromic acid titration method. Soil Science. 37: 29 – 38.