

## Crassostreacucullata Shells As Indicator to Environmental Changes in The Iraqi Coastlines.



### Science

**KEYWORDS :** black holes, shells, environmental changes, Iraqi coastlines.

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### ABSTRACT

Surface holes were studied for hundred and sixty-seven of *Crassostreacucullata* shells that collected from Fadakia, Shatt Al-Basrah, and Iraqi coastlines (RassAlBishah, Khor Abdullah, KhorShytianah, Hacham Island, KhorAlZubair). These shells were studied as environment changes indicator in Iraqi marine territories. There are two main differences between river environment *Crassostreacucullata* shells and marine shells; the first difference is the abundance and highly distribution of holes on the surface area of *Crassostreacucullata* shells of river water than those shells of marine water. The second is the degree of *Crassostreacucullata* shells growth, whereas the river shells are smaller and thinner, the marine shells were bigger and thicker. Calcium, magnesium, sodium, chloride, iron and trace elements are increase in the marine shells in RassAlBishah, Khor Abdullah, KhorShytianah, Hacham Island, KhorAlZubair compare with the river shells in Fadakia and Shatt AlBasrah areas as a result to increase of these elements in the sea water compare with river water. Phosphor element in Fadakia shells (river shells) is higher than the other shells, which may be probably due to the phosphorus-rich fertilizers transported from agricultural land near for Fadakia area by Shatt Al Arab river. Silica and aluminum elements are increase in Fadakia and RassAlBishah *Crassostreacucullata* shells (river shells) compare with the marine shells, that may be attributed to surface contamination in river *Crassostreacucullata* shells, and most of these elements concentrated in the holes of these shells.

### Introduction

Coastlines are sensitive to environmental conditions. The components of the shells are taken directly from the host water after moulting and use the elements (major, trace and rare earth elements) in molluscs shells as proxies for interpreting environmental record through combination of analysis of growth features formed in accretionary of hard part and geochemical analysis (Al- Jaberi, 2013, Surge and Walker ,2006 ; Fengeret *et al.*,2007). Shells occurred under differing environmental conditions tend to reflect those deference in the chemistry of shells, it likely that environmental information is record in the mollusc shell. The molluscs are the good source of information for studying periodic environmental changes (Al-Jaberi, 2013). *Crassostreacucullata* is a bivalve littoral shell, found in brackish-marine environments. The aim of this study is to detect the environmental changes in Iraqi coastlines by determine the differences in the shape and geochemical analysis of *Crassostreacucullata* shells in Shatt Al Arab, Shatt Al-Basrah rivers and Iraqi coastlines (RassAlBishah, Khor Abdullah, KhorShytianah, Hacham Island, KhorAlZubair) (Figure 1).



**Figure 1- Location samples in the study area**

### Material and methods

One hundred and sixty-seven of *Crassostreacucullata* shells were collected from south parts of Shatt Al Arab river in Fadakia area (25 samples), RassAlBishah (16 samples), Khor Abdullah (16 samples), KhorShytianah (15 samples), Hacham Island (15 samples), KhorAlZubair area (40 samples) and Shatt AlBasrah area (40samples). Twenty-eight shells selected from the total *Crassostreacucullata* shells and prepared for this

investigation. *Crassostreacucullata* shells samples separated from living soft tissues, washed with distilled water, exposed to ultrasonic radiation for 2 h to remove possible foreign materials, and then air-dried, graphite coated prior to test by scanning electron microscope- EDAX in Uppsala University - Sweden. Geochemical analysis for the river and marine shells calculated by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES), and Inductively coupled Plasma - Mass Spectrometry (ICP-MS) in the ALS Laboratory group in Spain and Sweden.

### Result and discussion

Progress of marine salt wedge from Arabian Gulf towards of Shatt Al Arab and Shatt AlBasrah rivers during years 2009, 2010, and 2011 caused to increase the salinity,  $Ca^{2+}$ ,  $Mg^{2+}$ ,  $Na^+$ ,  $K^+$ , and  $Cl^-$  in the water of these rivers (Table 1). These environmental changes allowed to marine *Crassostreacucullata* shells to live and reproduce in the banks of these water rivers. There are two main differences between the *Crassostreacucullata* shells that live in the water rivers (Shatt Al-Arab and Shatt AlBasrah rivers) and that live in Iraqi coastlines of marine water. The first is the size variation, and the growth rates of the marine water shores. The second is the occurrence of holes on the surface of *Crassostreacucullata* shells of the fresh water rivers (Shatt Al-Arab and Shatt AlBasrah rivers) with high intensity than the marine water shells in the studied Iraqi coast lines. There are various documentations about bivalves *Crassostreacucullata* shells growing faster in marine water shores (Van Someren and Whitehead ,1961, Seed, 1968, Morton,1977 ,Sumner, 1981, Ruwa ,1988). The results of this study reflect that the faster growth of *Crassostreacucullata* shells at Hacham Island, KhorShytianah, Khor Abdullah, RassAlBisha and KhorAlZubair as marine water coasts. This has been attributed to longer feeding hours for lower level because the immersion times are longer with high densities than the higher level in the Shatt AlBasrah and Fadakia (Shatt Al Arab) areas (Figures 2). The *Crassostreacucullata* shells in the study area are varies in length from site to site, whereas the length of *Crassostreacucullata* shells in Shatt Al-Basrah and Fadakia area were smaller and thinner than the other shells in the Iraqi coastline (Table 2). The second difference between river shells and the marine shells is the occurrence of holes on the surface of *Crassostreacucullata* shells. Whereas Fadakia and Shatt AlBasrah *Crassostreacucullata* shells had many of holes on their surface, the coastline Cras-

sostreacucullata shells had not or less (Figures 3). This may attribute to the solution erosional processes of Shatt Al Arab and Shatt AlBasrah water rivers, which is under saturated by calcium ions. Therefore, it is believed that the solution erosion processes by rivers water caused to pull out the calcium ions from surface of Crassostreacucullata shells and uptake the needed calcium elements and leaves behind these holes (Figure 3). These processes also caused the thinning of the Crassostreacucullata shells in the Fadakia and Shatt AlBasrah area. On the other hand, these holes are so little or were not existed on the surface of coastline shells because the sea water is supersaturated with calcium ions that kept the surface of these shells safe from any damage (Figure 3).

**Table 1- Hydrochemical analysis for the water in the study area**

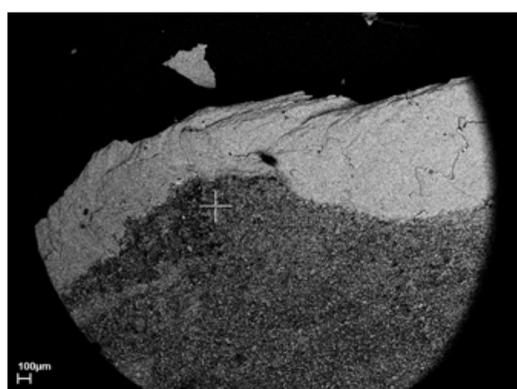
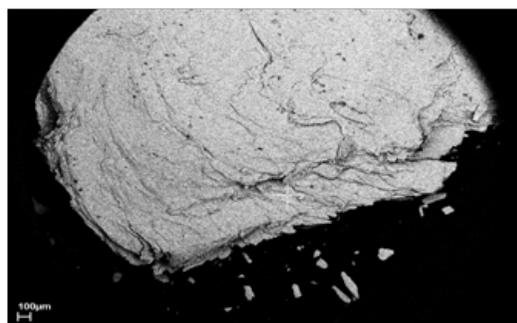
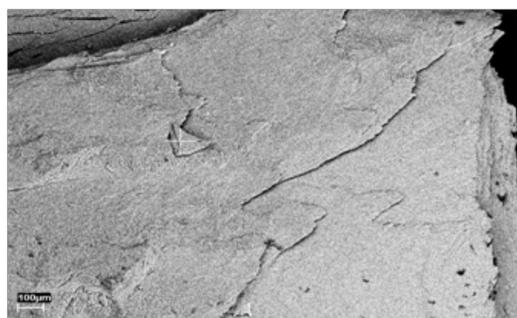
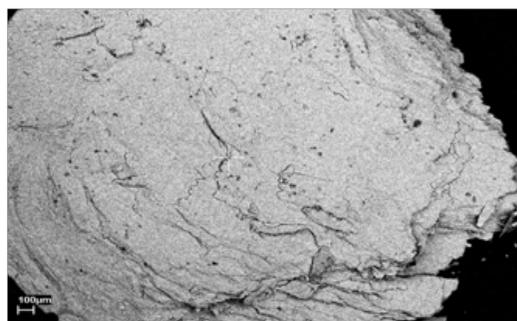
| Position       | Salinity ‰ | Ca <sup>2+</sup> ppm | Mg <sup>2+</sup> ppm | K <sup>+</sup> ppm | Na <sup>+</sup> ppm | Cl <sup>-</sup> ppm | Pb ppm | Fe ppm | Co ppm | Ni ppm |
|----------------|------------|----------------------|----------------------|--------------------|---------------------|---------------------|--------|--------|--------|--------|
| KhorAlZubair   | 42         | 578                  | 1566                 | 358                | 13950               | 24321               | 0.13   | 1.88   | 0.89   | 0.98   |
| Hacham Island  | 41         | 567                  | 1500                 | 311                | 13940               | 24320               | 0.14   | 0.985  | 0.411  | 0.519  |
| KhorShytianah  | 45         | 610                  | 2040                 | 317                | 15100               | 26800               | 0.21   | 2.278  | 1.593  | 1.8    |
| Khor Abdullah  | 39         | 513                  | 1482                 | 320                | 13028               | 22846               | 0.13   | 1.066  | 0.593  | 0.783  |
| RassAlBishah   | 35         | 465                  | 1441                 | 390                | 10675               | 20261               | 0.05   | 1.78   | 0.753  | 0.743  |
| Fadakia        | 14         | 285                  | 1043                 | 106                | 4413                | 8768                | 0.035  | 0.86   | 0.42   | 0.42   |
| Shatt AlBasrah | 18         | 412                  | 1208                 | 78                 | 4654                | 9066                | 0.13   | 1.88   | 0.89   | 0.98   |

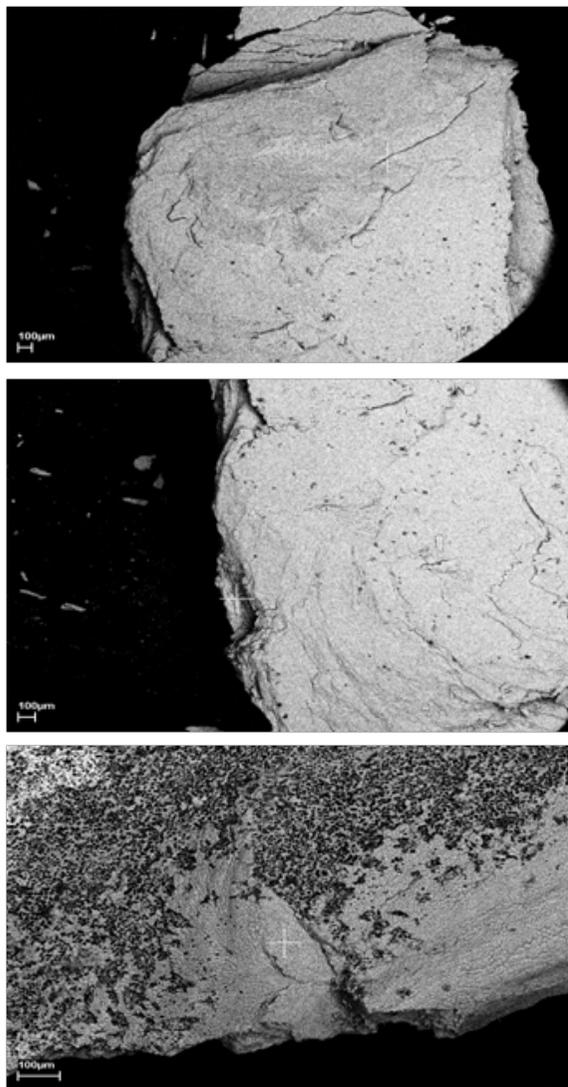


**Figure 2: Various sizes of Crassostreacucullata shells in the study area. F: Fadakia, B: RassAlBishah, A: Khor Abdullah, S: KhorShytianah, H: Hacham Island, Z: KhorAlZubair, SB:ShattAlBasrah**

**Table 2: Lengths of the Crassostreacucullata shells in the study area**

| Sampling Site  | Shells Length Range (cm) | Shells Mean length (cm) | Environment salinity ‰ |
|----------------|--------------------------|-------------------------|------------------------|
| KhorAlZubair   | 5.0-5.5                  | 5.3                     | 42                     |
| Hacham Island  | 7.6-8.1                  | 7.9                     | 41                     |
| KhorShytianah  | 5.6-6.2                  | 5.9                     | 45                     |
| Khor Abdullah  | 5.2- 5.9                 | 5.6                     | 39                     |
| RassAlBishah   | 5.1-5.8                  | 5.5                     | 35                     |
| Fadakia        | 3.1-3.8                  | 3.5                     | 14                     |
| Shatt AlBasrah | 3.5-4.0                  | 3.7                     | 18                     |





**Figure 3: Outer surface of Crassostrea shells in the study area under SEM in size of 100 µm show the comparison between the holes on their surface in the marine and river shells. A- KhorAlZubairCrassostrea shell (marine shells) B- HachamCrassostrea shell (marine shells) C- KhorShytianahCrassostrea shell (marine shells) D- Khor Abdullah Crassostrea shell (marine shells) E- RassAlBishahCrassostrea shell (marine shells) F- Shatt AlBasrahCrassostrea shell (river shells) G- FadakiaCrassostrea shell (river shells).**

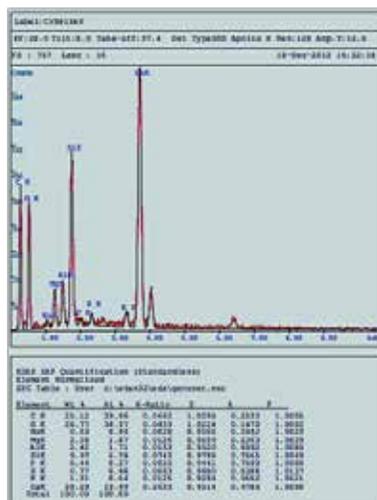
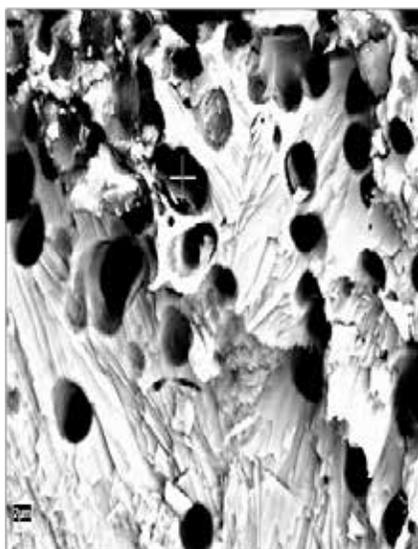
Calcite in the marine shells of KhorAlZubair , Hacham Island , KhorShytianah, Khor Abdullah , and RassAlBishah are higher than river shells in the Fadakia and Shatt AlBasrah (Table 3), as a result to higher content of  $Ca^{2+}$  ions in the surrounding sea water compared with the Shatt Al Arab river in Fadakia area and Shatt AlBasrah river as shown in table (1), and because the solution erosional processes by the river water on the surface of Shatt Al Arab and Shatt AlBasrahcrassostrea shells caused to decrease the calcium content. In addition to, magnesium (MgO) and sodium ( $Na_2O$ ) are higher in the marine Crassostrea shells (KhorAlZubair , Hacham Island , KhorShytianah, Khor Abdullah, and RassAlBishah ) compare with the river shells in the Fadakia and Shatt AlBasrah , as a result to higher content of these elements in the sea water compare with the rivers water (Tables 1 and 3) . Moreover, Mg/Ca and Sr/Ca values in the marine Crassostrea shells are higher than river shells in Fadakia and Shatt

AlBasrah areas, that may be due to increment of salinity and temperature in the coastal line compared with Fadakia and Shatt AlBasrah area, this result is work with the hydrochemical analysis for the water in the study area (Table 1), where increase the salinity in the sea water compare with the water of Shatt Al Arab in Fadakia area and Shatt AlBasrah river. But on the other hand, the water salinity of south parts of Shatt Al Arab and Shatt AlBasrah rivers is higher compared with the global fresh water, so the classification of water in these rivers is brackish to saline water according to classification of Lewis (1982) and Klimentove (1983), and that allowed for Crassostrea shells to live and reproduce in these parts of rivers but in smaller size compared with the coastline shells. The salinity and calcium ions in the water may be connection in positive relationship with the size of Crassostrea shells. Strontium averages in the marine Crassostrea shells of KhorAlZubair, HachamIsland ,KhorShytianah, Khor Abdullah and RassAlBishah are higher than the strontium content in the shells of Fadakia and Shatt AlBasrah (Table 3) , that may be attributed to higher strontium content in the sea water . Davis (1971) mentioned the Sr ion content in sea water is 8ppm, while in river water is 0.5 ppm. Mn, Ti, Zn, Cu, Ba, Co, Cr, Pb, Ga, Hf, Nb, Ni, Rb, Th, U, V, Y, and Zr elements were higher in the marine shells of KhorAlZubair, Hacham Island, KhorShytianah ,Khor Abdullah and RassAlBishah than river Crassostrea shells of Fadakia and Shatt AlBasrah, as a result to higher content of these elements in the surrounding sea water , especially in the KhorShytianah. . Correspondingly, these shells are very sensitive to pollutant, so many of previous studies used these shells as indicator to the pollution in the coastal sediments. Gold-Bouchot et al (1997) calculated the hydrocarbon concentration in Crassostrea shells in the coastal lagoon of Tabasco in Mexico. Afaj and Al-Dabbas (1998) stated the iron (162 ppm) , manganese (15 ppm) , zinc (20 ppm) , and copper (20 ppm) in the Crassostrea shells of KhorAlZubair area. Aguilar et al (2012) determined the Barium (1.3 ppm), Copper (19.6 ppm), Cadmium (1.27 ppm), Chromium (1.15 ppm), and Vanadium (1.99 ppm) as pollutant elements in the Crassostrea shells of coastal zone in Terminus-Mexico. Berges-Tiznado et al (2013) examined the bioavailability of arsenic through the mangrove Crassostrea in the coastal lagoon of California Gulf as concentration of 5.2-11.6 ppm. The Heavy metals (Ba, Co, Cr, Pb, Zn, Cu, Ga, Hf, Nb, Ni, Th, V, Y, and Zr ) in KhorShytianah shells are more than the other shells in the study area, that may be an indication to the contamination of this part of Arabian Gulf by these elements , and this result agree with the hydrochemical analysis, whereas increase of lead, cobalt and nickel in the Iraqi sea water , especially in khorShytianah water (Table 1) . While increase the rubidium element in KhorAlZubair-Crassostrea shells, uranium and manganese elements in Hacham Island Crassostrea shells compare with the other shells in coastline, that might be due to contamination of these areas by rubidium, uranium and manganese elements. Potassium element in RassAlBishahCrassostrea shells is more than the other shells as a result to higher potassium ions content in the sea water of RassAlBishah and that correspond with the hydrology study for this area (Table 1). Phosphorus element in Fadakia shells (river shells) is higher than the other shells, which may be probably due to the phosphorus-rich fertilizers transported from agricultural land near for Fadakia area by Shatt Al Arab river. Scanning electron microscope - EDAX (Figures 4 and 5) and table (3) showed that Al and Si elements represented in higher concentration in Fadakia and RassAlBishahCrassostrea shells (river shells) compare with the other shells in the study area (marine shells), that may be attributed to surface contamination in Crassostrea shells, and Most of these elements concentrated in the holes of these shells as noticed in the Figures 4 and 5.

**Table 3- Means of major and trace elements for Crassostreacullata shells ( SB- Shatt AlBasrah, Z: KhorAlZubair, H: Ha-cham Island, S: KhorShytianah, A: Khor Abdullah, B: RassAlBishah, F: Fadakia).**

| Elements                         | SB     | Z      | H      | S      | A      | B       | F      |
|----------------------------------|--------|--------|--------|--------|--------|---------|--------|
| CaO %                            | 53.7   | 54.7   | 54.8   | 54.9   | 54.5   | 54.3    | 53.8   |
| MgO %                            | 0.56   | 0.75   | 0.701  | 0.78   | 0.66   | 0.61    | 0.53   |
| SiO <sub>2</sub> %               | 0.695  | 0.413  | 0.249  | 0.31   | 0.345  | 0.212   | 0.852  |
| Al <sub>2</sub> O <sub>3</sub> % | 0.505  | 0.0976 | 0.0652 | 0.072  | 0.096  | 0.091   | 0.514  |
| K <sub>2</sub> O %               | 0.08   | 0.178  | 0.132  | 0.163  | 0.14   | 0.188   | 0.021  |
| Na <sub>2</sub> O %              | 0.387  | 0.417  | 0.399  | 0.436  | 0.391  | 0.393   | 0.312  |
| MnO %                            | 0.0028 | 0.0188 | 0.0437 | 0.0214 | 0.0177 | 0.0121  | 0.0037 |
| P <sub>2</sub> O <sub>5</sub> %  | 0.0677 | 0.0576 | 0.0302 | 0.0327 | 0.0124 | 0.06128 | 0.13   |
| TiO <sub>2</sub> %               | 0.0026 | 0.0054 | 0.0535 | 0.0165 | 0.0045 | 0.003   | 0.0081 |
| Sr ppm                           | 1001   | 1064   | 1084   | 2015   | 1033   | 1022    | 996    |
| Zn ppm                           | 218    | 224    | 235    | 240    | 232    | 220     | 217    |
| Cu ppm                           | 470    | 451    | 489    | 491    | 487    | 482     | 456    |
| Ba ppm                           | 4.17   | 10.6   | 8.92   | 27.2   | 9.932  | 7.4     | 14.4   |
| Co ppm                           | 0.48   | 0.922  | 1.05   | 2.33   | 0.88   | 0.722   | 0.52   |
| Cr ppm                           | 4.33   | 8.5    | 33     | 41     | 0.309  | 5.42    | 7.3    |
| Pb ppm                           | 0.0985 | 38     | 40     | 43     | 36     | 33      | 32     |
| Ga ppm                           | 30     | 0.13   | 0.96   | 1.21   | 0.23   | 0.11    | 0.1    |
| Hf ppm                           | 0.0485 | 0.093  | 0.097  | 0.131  | 0.077  | 0.064   | 0.044  |
| Nb ppm                           | 0.012  | 0.282  | 0.81   | 0.93   | 0.33   | 0.17    | 0.16   |
| Ni ppm                           | 5.517  | 8.88   | 6      | 8.7    | 7.75   | 7.13    | 4.492  |
| Rb ppm                           | 1.272  | 15.3   | 11.1   | 11     | 12.225 | 11.5    | 0.85   |
| Th ppm                           | 0.102  | 0.125  | 0.098  | 0.205  | 0.133  | 0.113   | 0.0725 |
| U ppm                            | 0.0595 | 0.053  | 0.74   | 0.347  | 0.34   | 0.0689  | 0.081  |
| V ppm                            | 1.18   | 1.42   | 1.56   | 4.74   | 1.362  | 1.23    | 1.05   |
| Y ppm                            | 0.21   | 0.46   | 0.32   | 0.52   | 0.386  | 0.283   | 0.198  |
| Zr ppm                           | 1.48   | 1.75   | 4.74   | 5.74   | 2.132  | 1.53    | 1.44   |
| LOI %                            | 41     | 42     | 42     | 42     | 43     | 43      | 41     |
| Sr/Ca x 1000                     | 2.61   | 2.724  | 2.727  | 5.142  | 2.65   | 2.633   | 2.593  |
| Mg/Ca x 1000                     | 8.84   | 11.66  | 10.31  | 11.99  | 10.202 | 9.433   | 8.317  |
| *Fe (wt %)                       | 6.2    | 6.5    | 5.2    | 7.9    | 5.5    | 6       | 4.8    |
| *Cl (wt %)                       | 0.65   | 0.81   | 0.74   | 0.88   | 0.72   | 0.68    | 0.55   |

**Note: Most the elements in Crassostreacullata shells detected by ICP analysis, just Cl and Fe (\*) elements detected by SEM-EDAX spectrum**



**Figure 4: Si, Mg, Al, Na, P, K, and S elements with Ca in FadakiaCrassostrea shells by SEM-EDAX in size of 2µm**

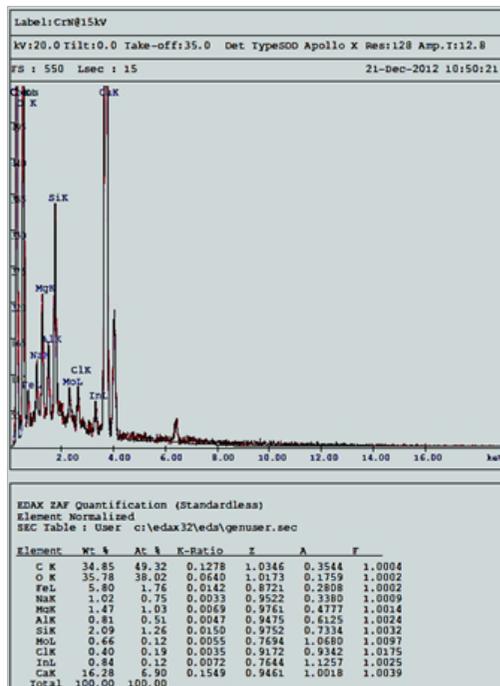
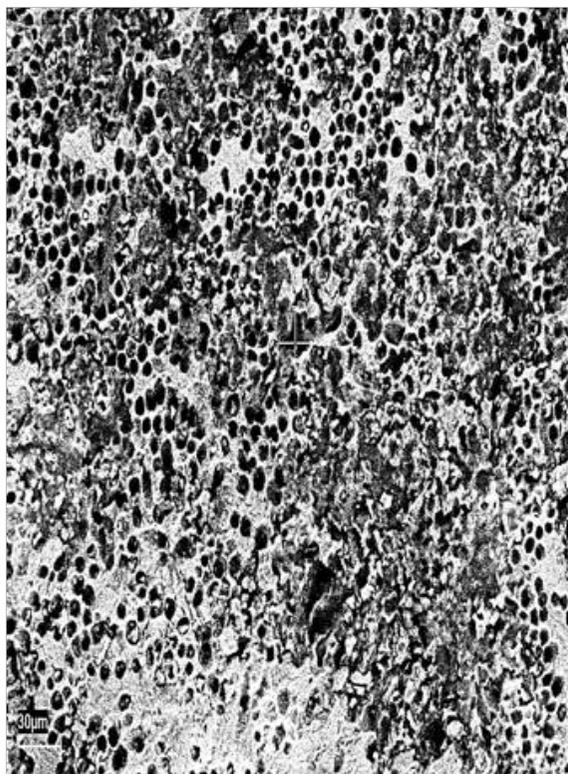


Figure 5: Si, Mg, Al, Na, Cl, Fe, Mo, and In elements with Ca in Shatt AlBasrah Crassostrea shells by SEM-EDAX in size of 30µm

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