Investigation of sedimentary controls on Urmia lake using sedimentological charachteristics of floor deposits(three 100 m Cores)

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Abstract:
The Urmia Lake is one of the largest hypersaline lake of the world, with average 6 m depth and 5000 to 6000 Km^2 area, in Azerbaijan, northwest of Iran. For this study 3 cores (approximately 100 m length) from internal parts of the lake were taken and then calssimetery , granolometery, SEM, XRD and separation of evaporates and organic matter analysis have been done on different subsamples of these 3 cores. The charts of evaporates, organic matters, carbonates as well as terrigenenous percentages are drawn versus depth. Main parts of sediments are including quartz, shard, feldspar, mica, pyroxene and clay minerals (Kaolinite, mica-illite, Montmorillonite). The most important terrigenous constituents are observed in subsamples that referred to the deeper parts of the basin which form 40-50 % of total sediments. chemical and biochemical constitutes which form 50-60% of sediments and consist of aragonites ooze, artimiya fecal pellets, coated grains and evaporates (gypsum and halite). Sedimentological evidences of the sequences indicate that salinity has been increased through the time and sediments were deposited in a saline to hypersaline environments associated with terrigenous, chemical and biochemical alternatives. Chemical and biochemical sediments have been formed in arid periods whereas terrigenous sediments are related to humid climate. Finally the total correlation between 3 cores was done and trasgressive period (sandy and silty horizons) as well as regressive period (evaporate laminations with pellets and organic matter horizons) are recognized.

Key Words: *Urmia Lake, Sedimentology, Hypersaline environemt, Trasgressive and Regressive.*

Introduction

Urumieh Lake is the biggest supra-saturated lake of salt in the world. It has a length of 140km, and width of 15 to 50km. Its changeable area is about 5700 sqkm at northwestern part of Iran (Samad Alipour 2006). The average depth of the lake is 6m, and its maximum depth is 13m. The height of lake water level is 1284m from open sea level. Soluble salts in lake water value vary from 217 to 280gr/lit (Shahrabi 1985). The saline water of Urumieh Lake, includes Na, Ca, chloride & sulphate (Mahajer & Bavaghar 1376).

Sedimentology studies

Sedimentology studies are based on 204 samples prepared from 3 cores; CB2 from depth of 100.5m, CB16 from depth of 40m and CB25 from depth of 99.7m.

Evaporatives separation

This test was carried out on 79 samples prepared from core CB25, 93 samples prepared from core CB2, and 32 samples prepared from core CB16 by washing method. Meanwhile, the evaporatives-depth graph was designed for all three cores.

Organic matters separation

Organic matter separation was carried out on 93 samples prepared from core CB2, 79 samples prepared from core CB25, and 32 samples prepared from core CB16 by hydrogen peroxide. Meanwhile, the organic matters-depth graph was designed for all three cores.

Calcimetry

Calcimetry was carried out on 93 samples prepared from core CB2, 79 samples prepared from core CB25, and 32 samples prepared from core CB 16 by weight method. Meanwhile, the carbonate percentage-depth graph was designed for all three cores.

Granulometry

This test was carried out on 93 samples prepared from core CB2, 79 samples prepared from core CB25, and 32 samples prepared from core CB16 based on sedimentology standards and by shaker sieve method and hydrometry (Tukr 1988). Meanwhile, the clastic sediments' percentage-depth graph was designed for all three cores.

Controlling factors of sedimentation

Sedimentological and textural characteristics of these three cores were determined by the following factors;

Study of ordinary samples, and clastic samples was carried out under the binocular and their correlation with evaporatives, organic matters, carbonates, clastic sediments-depth, and pellet-depth percentages. Due to high similarity of these sediments, and sedimentological characteristics of these three cores with each other, only graphs, and stratigraphical column of core CB25 from depth 99.7m was discussed.

Clastic materials, carbonates, evaporatives and organic matters are the most important sediment producers of Urumieh Lake, respectively.

Clastic sediments in form of sandy and silty layers, and clayey layers mixed by carbonates are in form of marly laminates are observed in stratigraphical column of these three layers.

Marly laminates together with inter-layers of clay and evaporatives are almost available throughout the core. Carbonates of Urumieh Lake sediments are in form of carbonate mud (marl) and fecal artemia pellets and ooliths (Shahhosseini 1382). Evaporatives are available in form of evaporative layers (gypsum, halite, etc.) and inter-layers with marl. Organic matters value is 2 to 4% within 100m of core. They appear in form of black lenses in particular depths.

-The graph of evaporatives percentage-depth indicates a reverse trend with depth. This means when depth increases, the percentage of ebaporatives cecrease in sediments. This situation exhibits the lake salinity increment as time goes by. Meanwhile, the percentage of salt increases and decreases in accordance with particular depths. When clastic materials are a lot in sediments, the percentage of evaporatives in sediments decreases. In the depths that artemia fecal pellet levels and organic matters are high in sediments, the percentage of evaporatives is also higher. When three wells are correlated with each other and with stratigraphic column of core CB25, the relative correlation appears in the depth of increment and decrement of salt percentage. Considering four lacustrine terraces studied by Schwitzer four periods of fluctuation are available about the lake water level which is in harmony with four peaks of increment and decrement of salt (Jedari & Eyvazi 1380).

- The graph of organic matters-depth indicates stable trend with 100m of sediments, and the value of organic matter varies between 1 to 3%. When the percentage of evaporatives and artemia pellets increases in special depths, the value of organic matters also increases. The origin of organic matter is mainly alga that is in form of phytoplankton at lake water level of mud and algal flats surrounding the lake. Remaining parts of *Artemia urumiana* and organic

matters produced on land transferring to the lake are the other source of the lake organic matter (Shahhosseini 1382).

Carbonate can be observed throughout the core. Comparison of the carbonates –depth graph with evaporative-depth and organic matter percentage-depth indicates a reverse situation. Considering that aragonite muds are the most important components of the lake carbonate sediments, and are mainly produced by temperature variation, CO2 emission from the environment and increment of CaCO3 concentration, when salinity increases by evaporation, algae consuming CO2 are killed. As a consequence of lack of activity of these algae, carbonate mud production also increases.

-Artemia is a shrimp that is specific to brine waters (Eimanifar et al 2006). Artemia fecal pellets percentage-depth graph, evaporatives-depth graph and organic matter percentage-depth graph of the lake indicate the same trend. Increment of pellets is along with increment of organic matters and evaporatives in sediments. Since Artemia can live in a particular range of salinity when salinity of environment increases the growth of this living organism also increases. Pellet percentage-depth graph indicates pellets increase by increment of salinity. In deeper areas where the salt value is less in sediments, pellets are also less. Pellets are increased by decrement of depth and increment of salinity. Pellet percentage-depth graph indicates a reverse trend in comparison to clay-depth, silt and sand percentage-depth and carbonate percentage-depth graphs. Increment of pellets is along with decrement of classic materials in sediments.

-Clastic sediments of Urumieh Lake basin comprise clays, silts and sands having extra-basinal origin that are transferred into the lake by ephermal and permanent rivers. Clastic materials entry to the basin is increased within wet and inter-glacial periods. Hence, increment of clastic materials indicates transgression the lake water.

-Clastic materials-depth graph indicates a reverse trend in comparison to evaporatives percentage-depth. Availability of sandy and silty horizons in sediments indicates the rising period of the lake water (Figure 2). Clays are the maximum weight percentage sediments of Urumieh Lake. Analysis of obtained clays from the core indicates the formation of clay minerals, like mica, illite, kaolinite, montmorillonite and chlorite. The most important source of clastic materials for Urumieh Lake is rivers. The most important rivers of the lake are, the Simineh Rood, Zarrineh Rood, Gadarchay, Nazloochay, Shahrchay, Barandoozchay, zoolachay and Ajichay. Among these rivers, Ajichay has the most important role because it passes through Miocene evaporative and clastic formations (Mahajer & Bavaghar 1376).

-Stratigraphical column studies of cores and their correlation with carbonate percentage, organic matter percentage, clay percentage, silt and sand percentage, and pellet percentage with depth graphs produce valuable data respecting sedimentology changements of the basin. Existence of sandy and silty horizons in sediments indicates periods of more clastic materials entry to the basin. As a consequence, wet climate and inter-glacial periods indicate the transgression of lake water transgression. In the depths of 5/0 to 98/0, 84/5 to 87/90, 73/0, 54/5, 29/0, 26/6 to 24/0, silty and sandy layers are observed. This issue indicates a relative correlation between evaporative percentage-depth graph and stratigraphical column and graph. The existence of sandy and silty layers is along with salt percentage decrement in sediments (Figure 1).

-The availability of evaporative sediments layers along with fecal pellets and organic matter lenses (6/99, 5/19, 12/8, 9/26, 3/31, 3/36, 6/40, 5/6 to 41/48, 6/4, to 49/68, 3/5 to 69/74, 5/5, 80/0 to 81/5) indicates arid climate and regression lake water level. Similarity between stratigraphical column with evaporatives and organic matter percentage and also depth certifies this issue. Evaporative and organic matters percentages increase in these depths.

Results

-The most important sediment makers of Urumieh Lake are; clastic sediments (clay, silt and sand), carbonates, evaporatives and organic matters.

-Urumieh Lake water was not a saturated lake, but gradually it reached current over-saturated conditions.

-Climate change produced changement in the Lake water level. Transgression periods are determined by sandy and silty horizons, and regression periods is recognized by evaporative horizons, fecal pellets and organic lenses. Existence of marly laminations and inter-layers of clay and evaporatives indicates intermediate periods

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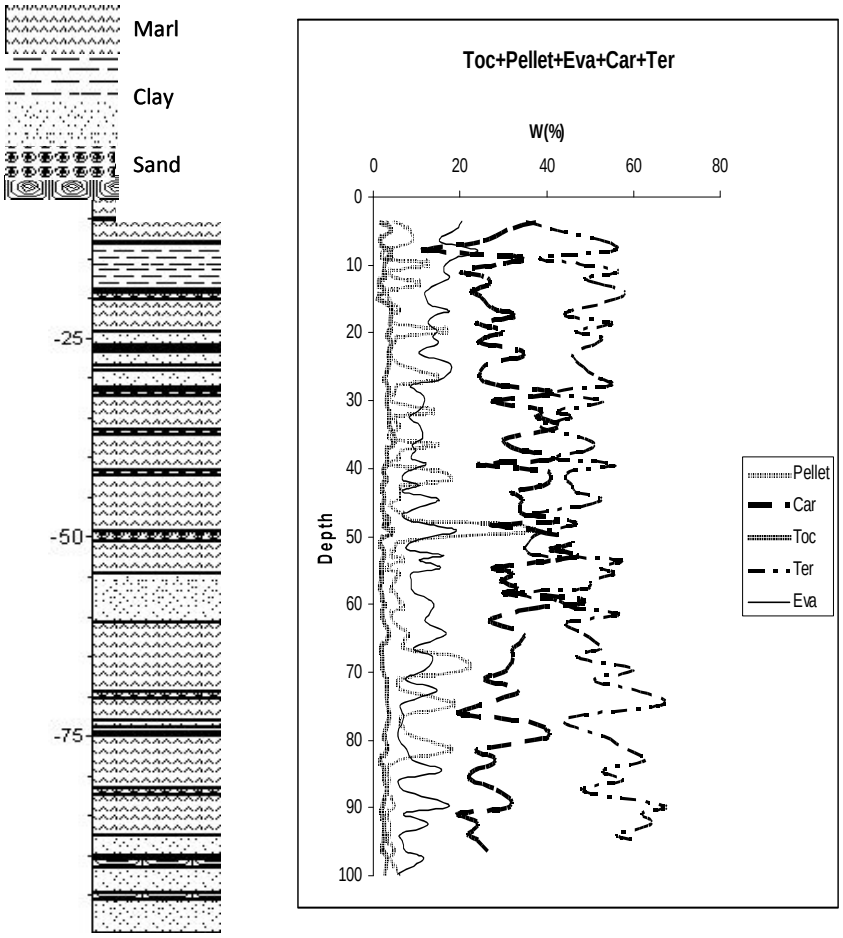

Figure 1: Stratigraphy Culms for one sedimentary Core

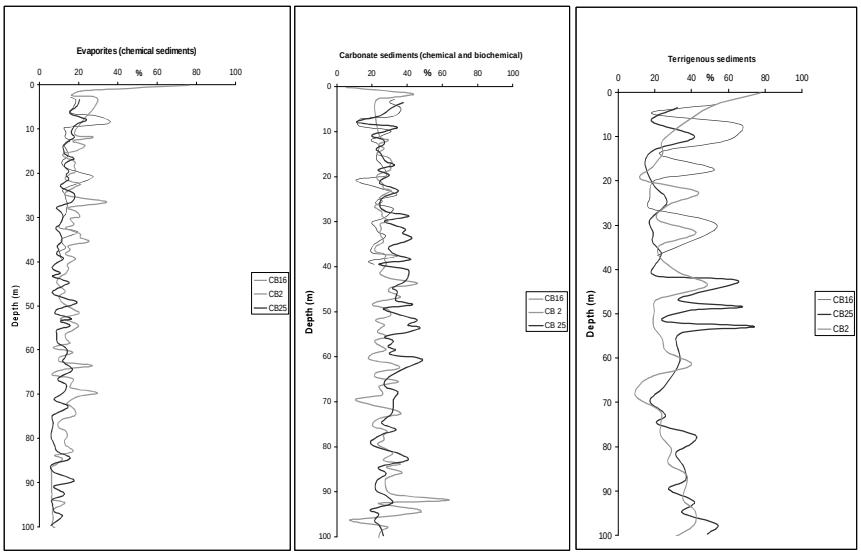

Figure 2: Distribution of Clastic particles (Right), Carbonate (middle) and evaporate (left) in study cores and changing this parameter with depth