Sedimentary Evidence of Climate Changes in Holocene, Zeribar Lake

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Extended Abstract

Introduction

Lakes are very interesting sedimentary environments for study of ancient climate changes in the environments and lake level changes. Lake Zeribar is situated in the province of Kurdistan, in the Zagros Mountains in three kilometers north-west of Marivan. The main purpose of this research is to study grain-size sediments accumulated in Zeribar lakes in order to check the water level fluctuations, climatic and environmental changes during the Holocene. Grain-size of the lake sediments is mainly controlled by the distance of the core site from the shoreline, the kinetic energy of the lake circulation and the source of the sediments (Lerman, 1978). The sediments sorting principle states that the grain size of lake sediments becomes finer and finer from the shore to the center, and sediment belts of different grain-size can be distinguished. Lake Zeribar sediments, providing a record of climatic variations more than 40,000 years long, have been the subject of multidisciplinary investigations reported in several publications (among others: plant macrofossils by Wasylikowa, 1967, 2005; diatoms by Snyder et al., 2001; stable isotopes by Stevens et al., 2001). However, sediments of the lake have not yet been analyzed for grain-size, whereas it could reveal important information about the lake history and sedimentary process-geomorphology.

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Methodology

A 6.88 m long core was extracted from the west part of the lake by a standard chamber corer, the Russian corer, 50 cm in length and 5 cm in diameter.

Sediments were sampled at an interval of 1-10 cm. All samples were split into halves and weighed. One half was wet-sieved using a 63 μm diameter sieve. The >63 μm fraction (sand and granule) was dried and weighed for sand and granule content. The other half was analyzed for mineral type. The <63 μm fraction was analyzed using a laser diffraction particle size analyzer (Micro tec A-22, Analysette 22) which utilizes grain-size range, 0.001-2 mm. Samples were treated with 30% H_2O_2 to remove organic matters. The samples were further dispersed via 10 minutes of exposure in an ultrasonic bath just before size analysis. For the purpose of particle-size specification, the following scale used by Folk and Ward (1957) was adopted; granule: >2mm, sand: 2000-63 μm (-1 to 4ϕ), silt: 63-3.9 μm (4-8ϕ), and clay: 3.9-0.24 μm (8-12ϕ).

Radiocarbon dating of the sediments was performed for three bulk sediments using a standard Accelerator Mass Spectrometer (AMS) method at the Institute of Accelerator Analysis Ltd, Japan. The ^{14}CAMS dates were calibrated to years AD and calendar years BP using OxCalv.4.1 (Bronk Ramsey, 2009) and IntCal09 (Reimer et al, 2009).

Results and Discussion

Based on the patterns of long-term fluctuations in median, mean and mode sample diameters combined with the percentages of the clay: (<2 μm), silt: (2–63 μm) and sand: (>63 μm) size fractions, frequency curves, and lithology, the whole sediment record is divided into 4 subdivisions as A (688-528 cm, 8950-6870 calyr BP), B (528–423cm, 6870-5500 calyr BP), C (423–244 cm, 5500–3170 calyr BP), and D (244–100 cm, 3170–1300 calyr BP) as described below, separately.

During phase A (688-528 cm, 8950-6870 cal BP) the percentage content of silt increases to ~74.8%, while the content of sand decreases to ~6.33%.

During phase B (528–423 cm, 6870–5500 calyr BP), the percentage of sand (average=14%) increases sharply while the percentage of silt (average=67.18%) decreases. The relatively high content of sand likewise implies a low lake level, which reflects effective moisture in the whole drainage.

During phase C (423–244 cm, 5500–3170 calyr BP) the percentage content of silt increases to ~77.4%, while the content of sand decreases to ~5.4% indicating high effective humidity and moisture in Lake Zeribar. The high and stable content of silt and fine components in the sediments indicates that lake-level reaches its highest value in the Holocene at this time.

During phase D (244–100 cm, 3170-1300 calyr BP), the content of sand (average=10.5%) increases while the content of silt (average=69.86%) decreases. Several cycles in grain-size may be related to centennial climate cycles. The high content of the coarse component suggest lake-level lowering.

Conclusion

The grain size data and descriptive statistics (mean, standard deviation, kurtosis, and skewness) showed various degrees of fluctuations in both short and long terms. Changes in climate and lake size appear to be the main factors affecting the variability in the grain-size distribution, properties, and type of minerals. The results of the data analysis suggests the existence of warm and wetter climate, increased spring rains, episode of higher lake water level, existence of fresh-water conditions, prevailing high-energy condition, dominance of erosional processes, seasonal supply of detritus, inflows strength and dominance of chemical weathering about 8950-6870 and 5500-3170 calyr BP. The results indicate the existence of dry climate, reduced rainfall, occurrence of drought, lake-level lowering, prevailing low-energy condition, absence of seasonal supply of detritus, conditions of tidal changes, and dominance of physical weathering about 6870-5500 and 3170-1300 calyr BP. It can be suggested that during the late Holocene 3170-1300 calyr BP variations of water-level occurred irregularly, as the results of precipitation changes, occasional lake overflows, and perhaps human activities.

Keywords: Climate Change, Lake Sediments, Lake Zeribar, Palaeogeomorphology.