

Holocene Lake-Level History of Lake Ugii as Suggested by the Diatom Analysis

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1. Introduction

Lake Ugii, Central Mongolia is located in valley of Orkhon Gol river, at the coordinate of 47°46'N, 102°44'E, in 1332 m a.s.l. Lake Ugii is a freshwater lake, about 25.7 in area. The length of the lake is 7.4 km with mean width 3.4 km (maximum width is 5.3 km). Mean depth of the lake Ugiis 6.6 km, but deepest point is 15.3 m (Tserensodnom, 2000). Different investigations of bottom sediments of the lake Ugii has been done by Narantsetseg (2001), Khosbayar et al. (2002), Walter et al. (2005), Zhang et al. (2008) and Wang et al. (2008).

This paper makes an attempt to reconstruct the paleoclimate and paleoenvironmental changes in Holocene based on results of diatom analysis of the UN-2004 core, obtained from the east-central part of Lake Ugii during the Mongolian-Chinese joint expedition in summer of 2004.

2. Materials and methods

The core of UN-2004 with length of 850 cm was cut lengthwise and after the lithological description has been sub-sampled in 2 cm interval after 100 cm to the end of core. Sediment samples for quantitative diatom analysis were collected with 10 cm intervals (totally 75 samples) from core UN-2004. The top 100

cm not was analyzed (no more samples for this analysis). The slides for diatom analysis are prepared by combination method Fearn, Sullivan and Per Boden technique with few modifications. At least 500 diatom valves per slide were counted on random transects at 400X magnification and diatoms were identified at 1000X magnification under an oil immersion objective on an NICON HFX-II microscope. The diatom valve concentration per gram dry sediments is calculated after the Per Boden (1991).

Additionally, in other to determine the relative water content, organic and carbonate contents of sediments, was used Loss on ignition analysis for the 109 samples (approximately 5-10 cm intervals) from UN-2004 core. Loss on ignition for the sediment cores was determined by heating the selected samples at 105°C, 550°C and 1000°C, respectively (Dean, 1974).

3. Results and discussion

3.1. Lithology and chronology

According to the visual description, the sediment of core UN-2004 consists of 3 main lithological units. Sediment unit 1 (852-484 cm) consists of grey-brown clayey silt. Sediment unit 2 (484-242 cm) is a light-grey silt layer containing 2 carbonate rich sub-units (at 450-492 cm and at 368-348 cm). Sediment unit 3 (240-0 cm) is a grey clayey silt layer. The cores chronology

is based on the 11 of AMS ^{14}C dates measured at the NSF-Arizona AMS Faculty, USA. According to this dates, the age of the bottom of the UN-2004 sediment core was estimated to be 8660 cal. yr BP (Wang et al., 2008).

3.2. Diatom Record in Holocene sediments of the Lake Ugii

In a result of diatom analysis were identified main dominant species in sediment cores of UN-2004 from Lake Ugii. Diatoms are abundant in all of the samples and species diversity is very high. The main planktonic dominant genera in Lake Ugii sediment are *Aulocoseira*, *Stephanodiscus* and *Cyclotella*. Among benthic (bottom) diatoms, main genera are *Cocconeis*, *Epithemia*, *Fragilaria*, *Amphora*, *Achnanthes*, *Cymbella* and *Suriella* and other. Of these, 3 genera *Cocconeis*, *Epithemia* and *Fragilaria* are found almost at all samples. Other benthic diatoms such as *Amphora*, *Achnanthes*, *Cymbella* and *Suriella* and others are not common in all samples.

As stated above, the main planktonic genera *Aulocoseira* presented in several species. Of these, *Aulocoseira granulata* is more abundant through the down core of sediments. The other species such as *Aulocoseira alpijiena* is not common in all samples. Genera *Stephanodiscus* presented in 2 species. Benthic diatoms such as genera *Cocconeis* and *Epithemia* are presented in 4 and 3 species respectively.

The profile of diatom abundance and generic composition change recorded sediment of core UN-2004 allow as to distinguish 8 periods in the development of the Lake Ugii diatom flora during the Holocene. These are identified by the Roman numerals I–VIII, from the base of core upward.

1. Diatom zone I (850 to 770 cm).

Zone I is characterized by relatively high abundance of the benthic diatoms, such as *Cocconeis* and *Epithemia*. Total amount of benthic diatoms is high (to 8–10 mln valves per gram of dry sediment). Opposite condition occurred on distribution of planktonic species. Their

amount decreases in this zone. The ratio of total planktonic and benthic diatoms shows that the zone I is characterized by low stand of lake water level.

2. Diatom zone II (770–725 cm).

Zone II is distinguished by high amount of planktonic diatoms, especially *Aulocoseira granulata*. The amount of bottom diatoms such as *Cocconeis* and *Epithemia* decreases. The ratio of total planktonic and benthic diatoms is high (about 80), indicating a rise of lake water level. The carbonate content decreases slightly compared to lower zone I.

3. Diatom zone III (725–680 cm).

Zone III is characterized by poor abundance both of planktonic and benthic diatoms, except small increasing of *Epithemia* and *Stephanodiscus*. The ratio of total planktonic and benthic diatoms shows, the zone III is characterized by low stand of lake water level. In this zone, the carbonate content increases with decreasing of organic matter concentration.

4. Diatom zone IV (680– 590 cm).

Zone IV is characterized by mass initiation of planktonic genera such as *Cyclotella*, *Stephanodiscus* and *Aulocoseira*. Their amount is relatively higher than lower zones (mean 60–100 mln valves per 1 gram of dry sediment). With regard to the distribution of benthic diatoms, their quantity decreases, indicative of the high stand of water level. The ratio of total planktonic and benthic diatoms, organic and carbonate content in sediments support this point.

5. Diatom zone V (590–290 cm).

After the increasing of all planktonic species, amount of all species in per 1 g dry sediments in zone V decreases. Especially, *Cyclotella ocellata* and *Stephanonodiscus* (2 species) drastically decreases, indicating abrupt changes of environmental condition. Diatom zone V with a near zero ratio of planktonic to benthic diatoms suggests that the water depth of Lake Ugii was rather low in this time interval. The approximately estimated age of sediments of the zone V is 6500–2500 ^{14}C years. In this time interval, sediment geochemistry is also has changing, that indicating the

organic and carbonate contents. Also, the distribution of Fe/Mn and Rb/Sr ratios are support this point (Zhang et al., 2008).

6. Diatom zone VI (290-250 cm).

Diatom zone VI is characterized by relatively poor contents of both planktonic and benthic diatoms, indicating low natural water productivity of the lake. Ratio of planktonic and benthic diatom support this point. Also, in this zone, the content of organic matter is relatively low, thus support low natural productivity of lake catchments area.

7. Diatom zone VII (250-125 cm).

The zone VII is characterized by mass initiation of *Aulocoseira granulata* with increasing of benthic diatom such as *Epithemia*. The contents of *Aulocoseira granulata* and *Epithemia* genera increases abruptly to 60 mln and 1 mln valves per 1 gram of dry sediments, correspondingly. The distribution of other planktonic and benthic species is very poor in zone VII. The ratio of total planktonic and benthic diatoms indicating that the zone VII is characterized by high stand of lake water level. Zone VII is also characterized by low carbonate and high organic matter contents.

8. Diatom zone VIII (125-100 cm).

In diatom zone VIII, concentration both of planktonic and benthic diatoms abruptly decreases, indicating that lake water level dropped.

4. Conclusions

1. The distribution of diatom assemblage abundances and ratio of planktonic and benthic diatoms (with data of organic and carbonate contents) in the sediment of core UN-2004 allow to record the lake level changes and natural productivity condition during the Holocene around the Lake Ugii, Central Mongolia.
2. According to the diatom record, the water level of the Lake Ugii was higher between 7300 ¹⁴C to 6500 ¹⁴C years and 2400 ¹⁴C to 2200 ¹⁴C. The mass initiation of planktonic diatoms indicate high natural

water productivity during this time.

3. The time interval between 6500-2500 ¹⁴C years is characterized by relatively low lake water level, indicating long dry condition around the Lake Ugii area.

5. REFERENCES

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