Levels of the Baikal and Hovsgol Lakes in Holocence and Pre- Holocence Time

Proceedings: International Symposium of the Kanazawa University 21st-Century COE Program Vol. 1 (2003)
Edited by Naoto KAMATA

Levels of the Baikal and Hovsgol Lakes in Holocene and Pre-Holocene Time

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Abstract - Both Baikal and Hovsgol have similarity in their development during the last tectonic stage (app. 50 Ka), which is expressed in the stability of their spillways: Angara and Egiin Gol Rivers. The climatic changes could cause any reasonable decrease of the lake level, whereas an increase was strongly controlled by the spillway thresholds. These arguments call in question an existence of the descending stairs of the Late Pleistocene and Holocene terraces of these lakes.

I. Introduction

Change of the Baikal and Hovsgol levels and their representation is one of the most debated topics. Scientists described step-like series of the terraces, in many cases containing redeposited pebbles. Only youngest ones have estimates of geological age as well as direct dates. Submerged relief, and hydrological, ecosystem, and molecular biological models were also considered. For the Baikal, existing opinions are overviewed as follows [1, 2].

Higher levels are represented by 12-15 terraces locate in the range of 270 m above the lake level. They probably are in relation with changes of spillway of the Baikal water. The current Angara gate replaced the Kultuk-Irkut one 50-60 Ka BP, and the older Buguldeika-Manzurka gate have existed until the Middle Pleistocene. Carefully selected data about sinking of the level, such as submerged morainal landscapes, terraces, valleys and slope sediments, are in doubt by [1, 2], contrary to the hydrochemical calculations which show impossibility of drainless conditions for the periods longer than 10 Ka.

For the Hovsgol, 8 on-land terraces range in height 80-85 m, and three submerged ones on the depths of 20-40, 50-80, and 90-120 m, were revealed [3]. New seismic data [4] and geological observations [5] indicate significant and multiplex lowering of the level.

The Late Pleistocene and Holocene part of these terrace sequences, both in the Hovsgol and Baikal, consists of four descending steps (including modern one), which conventionally corresponds to the main stratigraphic members by the following rule: the highest terrace is the oldest. This model does not take into account data about the lower then now positions of the lake's level.

II. Methods and suggestions

Geological study of the lake banks was accomplished by hand drilling of the near-shore peat bogs, allowed us to obtain 14C dates. Decoding of the satellite images was very useful for the geomorphologic mapping of the key areas. Sites described in this article are shown in Fig. 1.

The Baikal and the Hovsgol have a spillway control of their level now, as well as in the past. The spillway barrier is relatively stable throughout single tectonic phase. Our investigations convinced us of the relative tectonic stability of the Baikal Rift depressions. There were no critical reconstructions of the main spillway borders during the last 40-50 Ka. Thus, the increase of the water supply of these lakes even in several times can provide a very small raise of their level. Such conditions do not allow the formation of stairs-like terraces, as it was described by previous investigators. Contra versa, decrease of the water supply is free of spillway control, and any climatically reasonable level is possible.

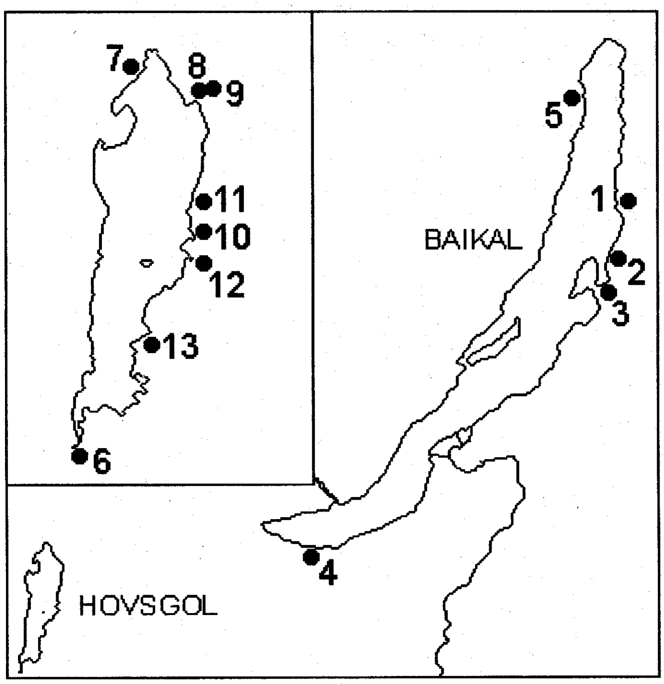

Fig. 1. Site map of the Baikal and Hovsgol. 1- Davsha; 2- Krohalinnaya Bay; 3- Arangatui Bog; 4- Pankovka River; 5- Cape Ludar; 6- Egiin Gol; 7- Ih Horoo; 8- Hanh Gol, Site 1; 9- Hanh Gol, Site 2; 10- Ih Dalbain Gol, 11- Tusgalyn Gol; 12- Bortsog Gol; 13- Nuuryn Gol.

III. Results

A The Baikal

We did not find lacustrine sediments and landforms, except the modern ones, that could be dated as the Holocene and Late Pleistocene, or correlated with the terrestrial sediments of the same age. The landforms, traditionally recognized as the lake terraces (I, II, and III), are gentle slopes and fans, and their distal parts are currently eroding by the lake. Well-represented outcrops show non-lacutrine origin of their sediments. A height of the benches of such "terraces" depends on what part of the landform is eroding.

The Davsha Bay is referred as the best place where all low terraces are represented [2]. We found that this shore outcrop is a cross-section of the fan or, in other terms, fluvioglacial cone of the Bolshaya River end moraine. The surface of this landform has typical channels, directed from the moraine toward the lake. The exposure is composed mainly by boulders and pebbles, and its height naturally follows the morphology of the embedded segments of this fan.

Fan landforms are typical for the glaciated northern and northeastern parts of the Baikal, whereas the slope formations and river deltas, covered by subaerial mixtites, prevail in the southern and western parts. All these terrestrial landforms eroding now have been accumulated in different stages of pre-Holocene and Early Holocene, and they obviously extended farther towards the lake, and the lake was out of these extents, i.e. smaller than today.

A hand drilling of the shore peat bogs allowed us to estimate probable depression of the lake level and its age (Table 1)

The Pankovka River outcrop represents a 4 m river terrace. Instead of the Holocene age (4600-1500 BP), this terrace is separated from the modern floodplain (1 m high), and corresponds to the earlier stage of the river activity. Anomalous thickness of the oxbow and floodplain sediments there can be arose from blocking the river's mouth by the lake. Cliff, corresponds to this or later transgression, cuts 4-m terrace, whereas the modern floodplain is superimposed on the lacustrine bench (Fig. 2). This bench itself gently declines toward the modern shoreline and shows gradual recession of the lake both due to accumulation of the shore sediments and decrease of the lake level.

TABLE I
Radiocarbon dates of the bottom of the shore peat bogs in the Baikal

Site	Depth below the lake level, cm	Radiocarbon age, BP
Krohalinnaya Bay	426	10,980+/-65 (AA-37968)
Arangatui Bog	474	9400+-60 (Beta-113968)

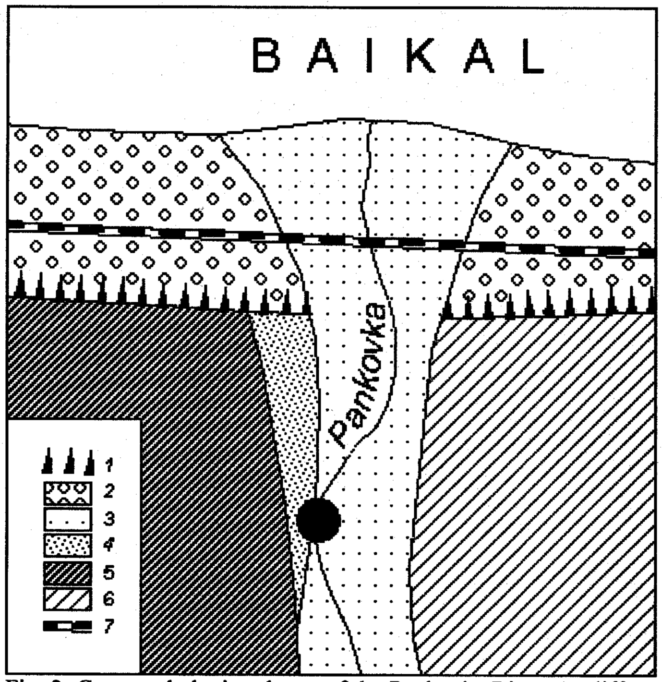

Fig. 2. Geomorphologic scheme of the Pankovka River. 1- cliff; 2- modern lake terrace; 3- floodplain and delta; 4- 4 m terrace (outcrop is marked by black dot; 5- highland, composed by Quaternary sands; 6- gentle slope of the right side of the valley; 7- Siberian railway.

B The Hovsgol

Valley of the Egiin Gol River, locate downstream from the place of its outflow from the Hovsgol, has only one morphological element: an extensive floodplain, bounded by scarps cut in the slope and fan deposits. This means that the Hovsgol's spillway has a very simple geological history. The very big Ulhen Sair fan, blocked the Egiin Gol valley in the headwaters, control this gate since the Late Pleistocene glaciations. Height of the marginal part of this fan cone, before it was cut in the Holocene, was about 6 m above the modern lake level. This value indicates the maximum level of the Hovsgol, which was possible during the Holocene and the second part of the Late Pleistocene.

The Hovsgol's level was extremely low during the glaciations [4, 5]. The Ih Horoo moraine, the largest one in the region, and slope covers occupied the dry bottom of the lake (Fig. 3).

Except that, we also found evidences of the lake levels higher than now. The Karginian river beds (Site 1 - > 45,000 BP, SOAN-4303; and Site 2 – 28,070±965 BP, SOAN-4743) are distributed in the Hanh Gol valley. We suggest the delta conditions for the Site 1 (3 km from the modern shore), where we found fine and organic-reach floodplain sediments of anomalous thickness, similar to the Pankovka River. The calculated lake level could be 6-7 m higher then now. River beds of the Site 2 (4 km from the modern shore), composed by coarse pebbles, can correspond to the lower position of the lake level.

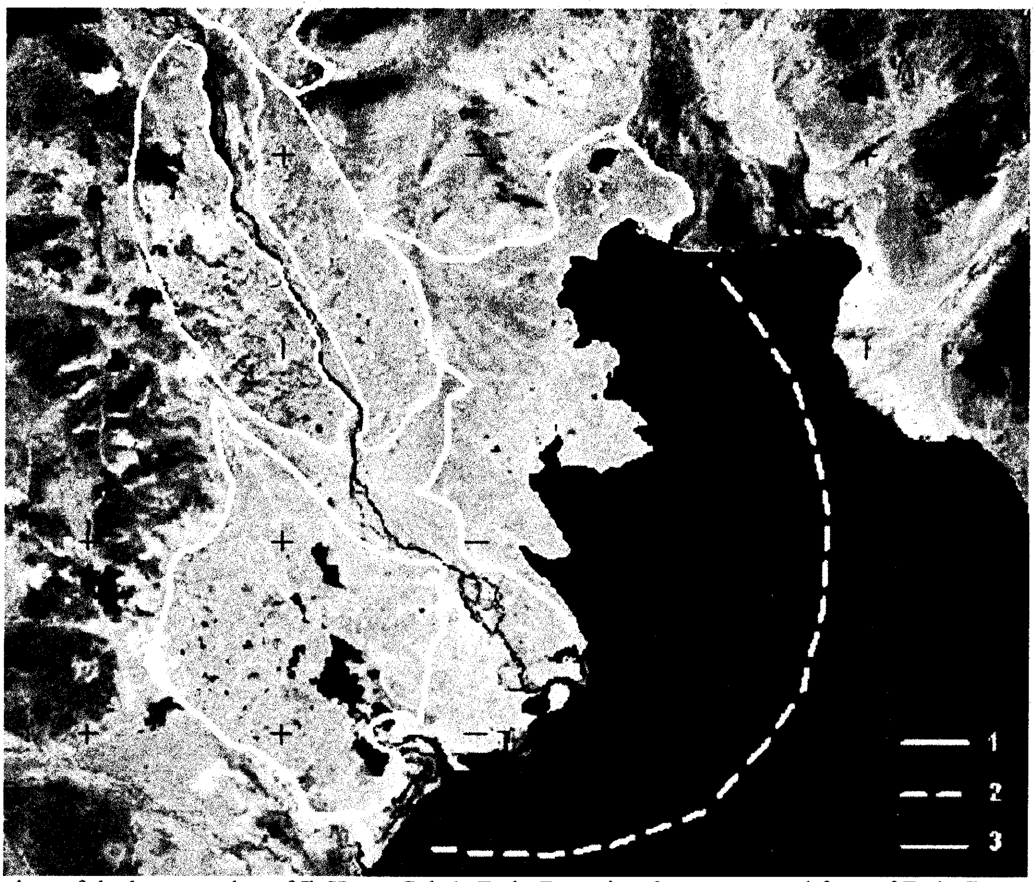

Fig. 3. End moraines of the lower reaches of Ih-Horoo Gol. 1- Early Zyryanian; 2- reconstructed front of Early Zyryanian moraine; 3- Late Zyryanian. (Landsat 7 satellite image.)

We suggest similar age for the littoral (gravels) and shore (pebbles) sediments of the Ih Dalbain Gol exposure, on the basis of palynological data. The top of coastal sediments is 1.5 m higher then the modern shoreline, but as this combination of layers indicates the regressive stage the transgression was larger than 1.5 m.

The one meter thick littoral gravel layer was found in the Tusgalyn Gol outcrop (Fig. 4). This also shows relatively deep-water conditions. The shoreline corresponds to this gravel is buried farther inland, with elevation of a few meters higher then the modern shoreline. We have no evidences of the age of this transgression, but simplicity of the cover sediments, compare with those of Ih Dalbain Gol, allowed us to assign this event to be younger, probably the Late Glacial.

Based on these data, we can consider that big ingression bays have occupied the mouths of the east-side Hovsgol's rivers during the warmer and wetter stages within the glacial epoch, and their traces are now covered by the subaerial sediments and are partially reworked by the consequent lake and river activities. Unfortunately, we can not identify extents of these buried terraces, but obviously the lowermost parts of the valleys of the eastern shore have to be classified as the lacustrine ones.

Contrarily to the buried Late Pleistocene terraces, the traces of the Holocene transgressions locate on the modern surface. Prints of the Holocene bays exist almost in every valley of the eastern shore, especially in the southern part of the lake (Fig. 4). In summer they are well indicated as the spots of bright-green grass. Their outer margin can be hardly recognized as a destroyed shore bar, which present the highest position of the lake in the Holocene, with elevation of one or two meters above the modern level. We assume the Early Holocene age of these bays because of absence of the cover sediments, and their incut by the floodplains. Later on, the deepest bays were dammed by spits, and separated parts became drainage lakes (Bortsog Gol, Tusgalyn Gol). A peat-like organic matter carried by the rivers, was accumulated on the bottom of such lakes. Radiocarbon dating of the presumably middle parts of these layers showed their Middle Holocene age (Nuuryn Gol - 2480 +/- 40 BP, Beta–163952; Bortsog Gol - 4510 +/- 40 BP, Beta–163953).

According to the data obtained by [6], the Hovsgol level was 5 m lower than now about 6000 BP, and then it rose unevenly. The modern Hovsgol transgression probably started at the end of XIX-th century. An evident 3 m increase of the level since the survey carried out by Peretolchin (1903), was described by [7] and [8]. A minor increase, caused by stone-runs of the Ulhen Sair fan, occurred in 1971-1972 [9]. This raise followed maximum 14 m inland shift of the shoreline.

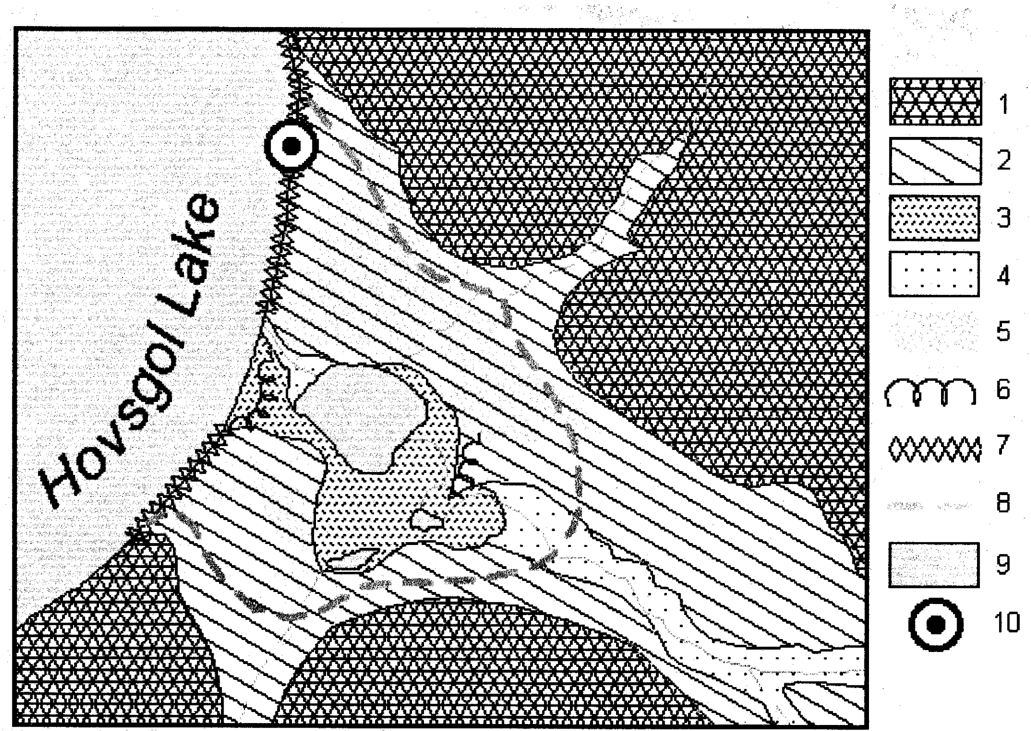

Fig. 4. Geomorphologic map of the Tusgalyn-gol lower reaches. 1- Mountain areas; 2- oblique plains: valley bottoms and slopes, Q_3^4; 3- Former bottom of bay, Q_4; 4- Floodplain Q_4; 5- Eolian sands, Q_3^4 and Q_4; 6- Beach ridges Q_4; 7- Abrasion scarps Q_4; 8- Reconstructed shorelines; 9- The Hovsgol Lake; 10- Outcrop.

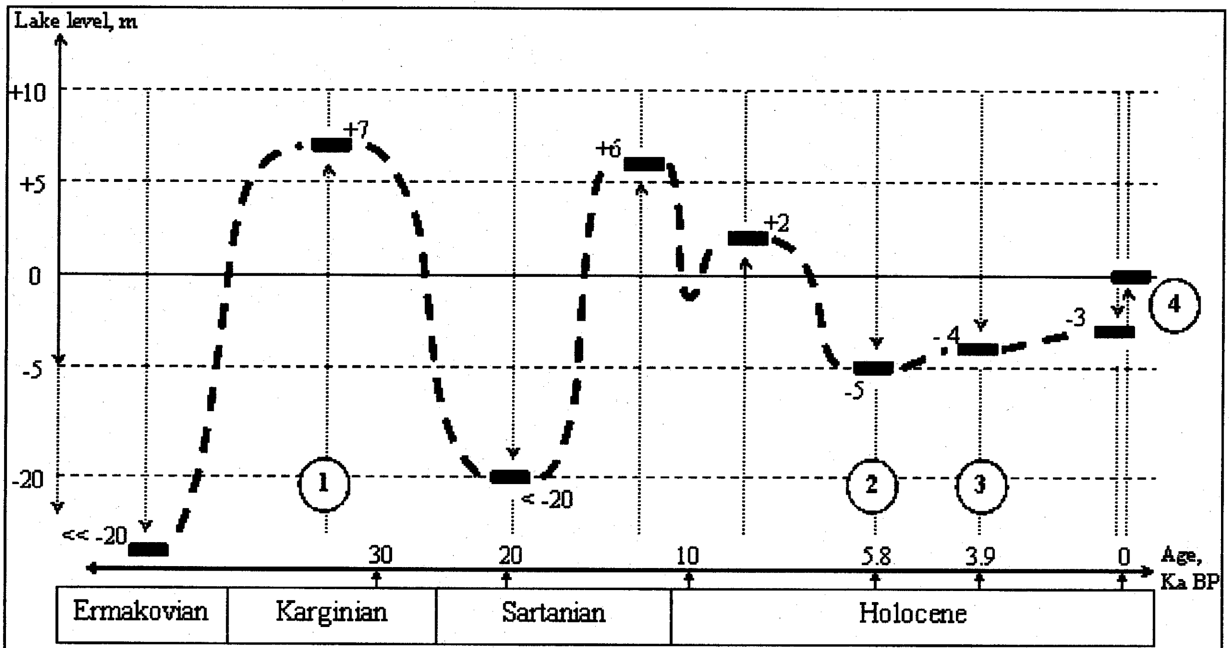

Fig. 5. Variations of the Hovsgol level in Late Pleistocene and Holocene time based on geological data. Numbers in the circles: 1-3 – levels dated by radiocarbon (1- >45 Ka BP, Hanh-gol; 2, 3 – 5800 ± 100 (TA-671) and 3910 ± 60 (TA-670), by [6]); 4- raise since the end of XIX-th century.

IV Discussion and Conclusions

Based on data presented, we can not believe in the stairs of the Late Pleistocene and the Holocene Hovsgol and the Baikal terraces. Instead of this, we can see traces of the recurrent but not the unilateral movements of their level. Transgressions had a very small scale, and the regressions were larger.

This problem is not well studied in the Baikal area. Neither traces of the lower levels nor the higher ones are well- documented. Our analysis of the information about the Holocene presented in [2], convinces us to revise the traditional viewpoint. The important evidence of transgression, locate at the Pankovka, has to be combined with data from the Cape Ludar [10] and other places. The situation in the Hovsgol is more understandable (Fig. 5). Thus, results of our dating of the transgressions are in agreement with the dating of regressive phases by [6].

The obvious facts of the deep drop of the Baikal in the glacial time find doubt on the grounds of hydrological and hydrochemical calculations in [2], whereas much larger (in respect to the size) reduction of the Hovsgol has no doubts. We can see the similarity of the control mechanisms between these two lakes. Decrease of their levels is controlled by climate. The level increase is similarly restricted by the stability of spillways. The highest transgression in both places had to be gradually decreased due to the cut of sediments, which were accumulated above the spillway threshold during the drainless stages. The range of decrease in the Hovsgol was about 6 m.

The Hovsgol now has a natural transgression. What was the trend of the Baikal level before the artificial increase 40 years ago? We suggest that it was at the stage of gradual decrease in harmony with the cut of the spillway threshold of the Angara River.

Acknowledgements

Author deeply appreciates Prof. Hikaru Takahara (Kyoto Prefectural University, Japan), Organizer of our joint investigation of the Baikal shores and peat bogs; and Prof. Frank Riedel (EDCA, Free University of Berlin, Germany) granted our Hovsgol research of 2002. Radiocarbon dating was kindly provided by Prof. Hikaru Takahara, Dr. Yaroslav V. Kuzmin (Pacific Institute of Geography, Vladivostok, Russia), Dr. A. J. Timothy Jull (University of Arizona, Tucson, AZ, USA), and Dr. Lyubov A. Orlova (Institute of Geology, Novosibirsk, Russia).

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