# Preliminary Investigations of Sediment Core Samples from the Tsola-Tso Lake, Khumbu Himal*

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## Abstract

During the winter of 1975, two core drillings of lake sediments were carried out in Tsola-Tso, Khumbu Himal and two cores, 1.99 and 3.07 m long, were obtained. Preliminary observations of the core lithofacies were made and are summerized as follows. 1) The lithofacies show the alternation of fine and coarse materials. 2) The thickness of each layer varies from 0.5 to 15 cm. 3) The core is classified into three part from the lithofacies, that is, top to 90 cm depth, 90 to 150 cm depth and below 150 cm depth.


## 1. Introduction

Bottom sediments of glacial lakes in the Himalayas will give valuable information of past environments, but the studies up to the present are few (e.g., Norin, 1927).

During the winter of 1975, core drillings of sediments of Tsola-Tso (Tso means lake) in Khumbu Himal were carried out from lake ice laid on the bottom. Tsola-Tso is a glacier dammed lake located at lat. 27°55′N, long. 86°47′E and 4,533 m above sea level in the Imja Khola basin, Khumbu Himal (Fig. 1). It was formed by the Tsola glacier during the recent advancing period, which is considered to coincide with the Little Ice Age (Iwata, 1976; Fushimi, 1978). No glaciers enter directly into the lake water, but many small glaciers exist in the lake catchment which is composed mainly of gneiss and migmatite. Though an outflow channel is not formed, the lake water is drained out through the bottom and/or the morainic dam during the dry winter season. The lake has an area of 0.66 km² and a length of 1.5 km at the height of the monsoon season.

## 2. Field work

Two core drillings were made at almost the same site of the deepest part of Tsola-Tso basin on January 28–29, 1975 and March 11–12, 1975, during a water free period when lake ice 30 to 50 cm thick was laid on the bottom. As shown in Fig. 1, the lake bottom inclines gently from upstream to downstream and the maximum water depth reaches 10 to 11 m around the coring sites in the mosoon season.

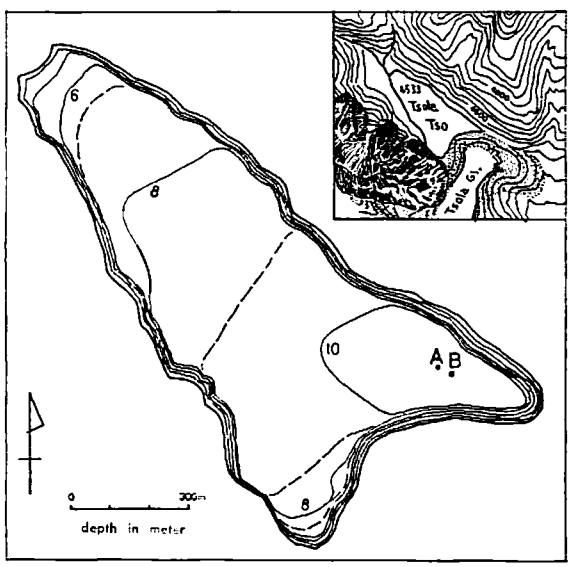


Fig. 1. Tsola-Tso and core drilling points.
A: Core drilling point (January, 1975)
B: Core drilling point (March, 1975)
The topographic survey was made by Fujii and Yasunari.

A polycarbonate pipe with an inside diameter of 4.5 cm was struck into the lake sediment (Fig. 2) and two cores 1.99 and 3.07 m long were obtained in January and March, 1975, respectively.

These cores were carefully brought back to


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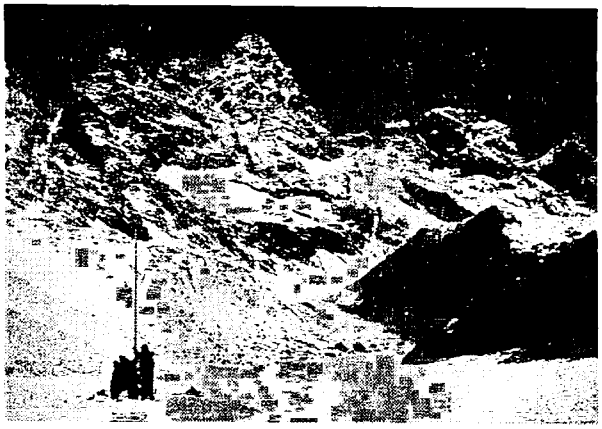

Fig. 2. Core drilling of lake sediments from lake ice laid on the bottom, Tsola-Tso, Khumbu Himal (March 12, 1975).

Lhajung Station (4.420 m above sea level, about 5 km southeast of Tsola-Tso) and oozed water from cored sediment was drained through small holes made in the pipe. The stratification of the wet sediment was disturbed partially by water which remained in the pipes, when these cores were transported from Lhajung Station to Syangboche airport (about 3,860 m above sea level, 13 km from Lhajung). The length of the analysed 3.07 m long core was shortened ultimately to 88 percent of the initial length by drainage of oozed water and drying shrinkage after cutting the pipes into two in August 1975 in Japan.

## 3. Core lithofacies

The columns of the 3.07 m long core samples are shown in **Fig. 3**. Although the core drilling points in January and March were fourty metres from each other, the two samples show similar lithofacies.

Roughly speaking, the lithofacies of the core sediments show alternation of fine material and coarse material. The fine materials are clay, silty clay, and silt including both clay and fine sand. The appearance is yellowish gray in colour with massive features; no apparent sedimentary structures, such as laminations and graded beddings, can be seen.

Coarse layers are composed of medium and fine sand containing biotite particles which appear as black stripes a few millimetre thick among the yellowish gray sand (**Fig. 4**). The thickness of each layer varies widely, from 0.5 to 15 cm, but a coarse layer and an adjacent fine layer often have similar thickness. Accordingly, the cores consist of many couples of coarse and fine layers.

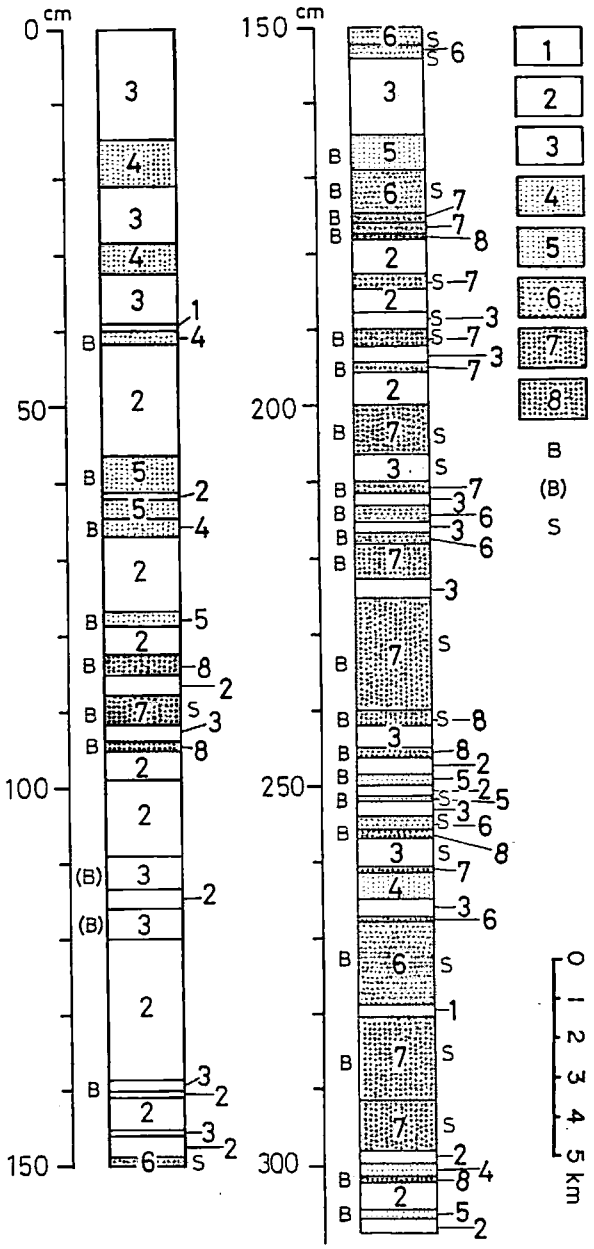


Fig. 3. Core sample columns.
1) clay 2) caly with silt 3) silt with clay and fine sand 4) fine sand with silt 5) fine sand 6) fine sand with medium sand 7) medium sand with fine sand and silt 8) medium sand
B: including biotite particles
(B): including a small quantity of biotite particles
S: black stripes of biotite

The cores are classified into three part from the lithofacies. From the surface to 90 cm depth, the core has a lot of thick silt and clay layers alternating with fine sand layers. Between 90 and 150 cm depth, the core is composed only of silt and clay material and below 150 cm depth, it contains a large quantity of medium sand with

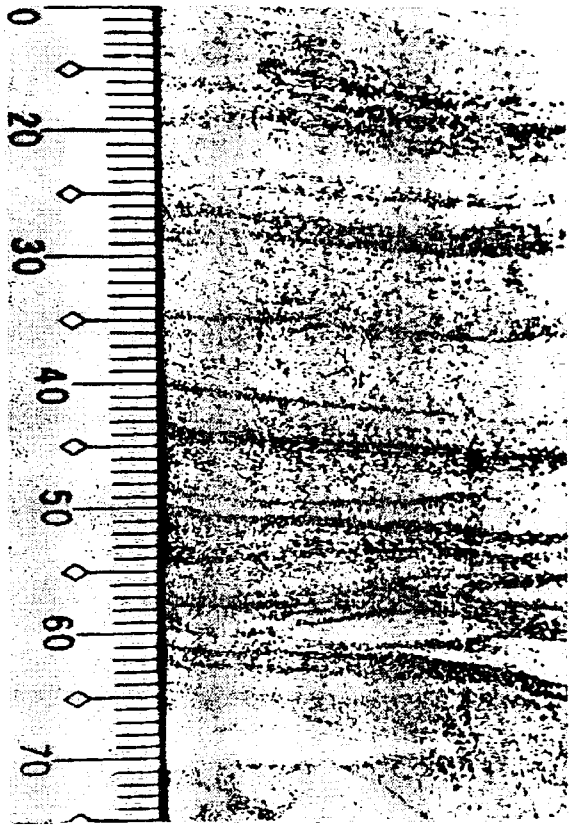


Fig. 4. Black stripes of biotite particles.

biotite particles.

It is considered that the size and thickness of the layers reflect variations of turbidity currents. In particular annual, seasonal, and daily variations of water flow and debris discharge affect the character of the accumulated sediment. The alternative beddings in glacial lake sediment are well known as varves. As couples of coarse and fine layers in varves are often between 0.5 and 5.0 cm in thickness (Price, 1973, p. 176), many layers in these core samples are too thick compared to typical varves. The different lithofacies of the three parts in this core suggest that the sedimentary environment changed at the 90 cm and 150 cm levels. Since no data on the sedimentation rates are available for this core sample at present, it is impossible to conclude whether the beddings correspond to the annual, seasonal, or daily variations of the lake water.

## 4. Remarks

The observation of the core lithofacies shows the alternation of fine and coarse materials with various thickness. This sedimentation feature will be discussed from some different points of views on another oppotunity on the basis of the core dating and the analyses of paleomagnetism and size distribution. The analyses of $Cs^{137}$, $Pb^{210}$ and remanent magnetization are underway by Dr. Kamiyama of Disaster Prevention Research Institute, Kyoto Univ., Prof. Tsunogai of Faculty of Fisheries, Hokkaido Univ. and Dr. Nishida of Institute of Natural Science, Ohtani Univ., respectively.

## References

Fushimi, H. (1978): Glaciations in the Khumbu Himal (2). Journal of Japanese Society of Snow and Ice, Vol. 40, Special Issue, 71–77.

Iwata, S. (1976): Late Pleistocene and Holocene moraines in the Sagarmatha (Everest) region, Khumbu Himal. Journal of Japanese Society of Snow and Ice. Vol. 38, Special Issue, 109–114.

Norin, E. (1927): Late glacial clay varves in Himalaya connected with the Swedish time-scale. Geogr. Ann. Vol. 9, 157–161.

Price, R.J. (1973): Glacial and Fluvioglacial Landforms. Oliver and Boyd, Edinburgh, 242 pp.